THE Petroleum Engineer

Tulsa, Oklahoma October, 1931

ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY

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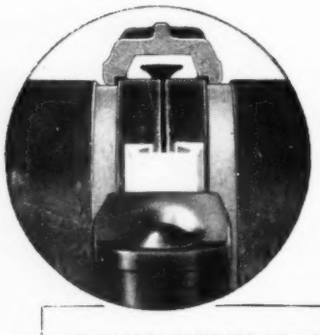

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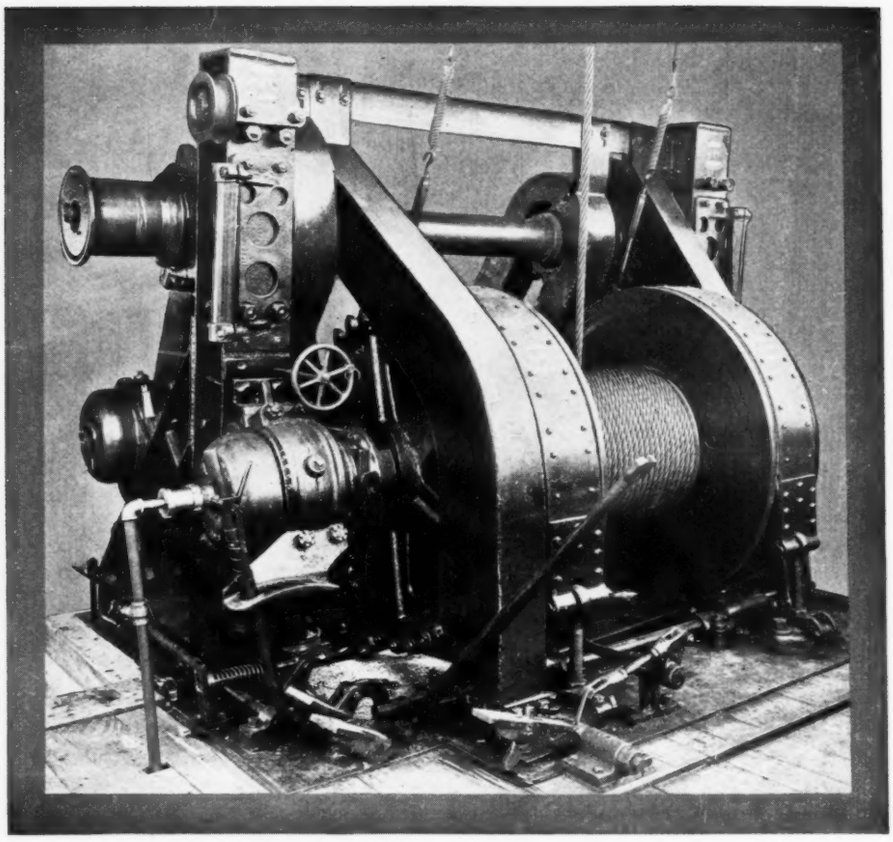

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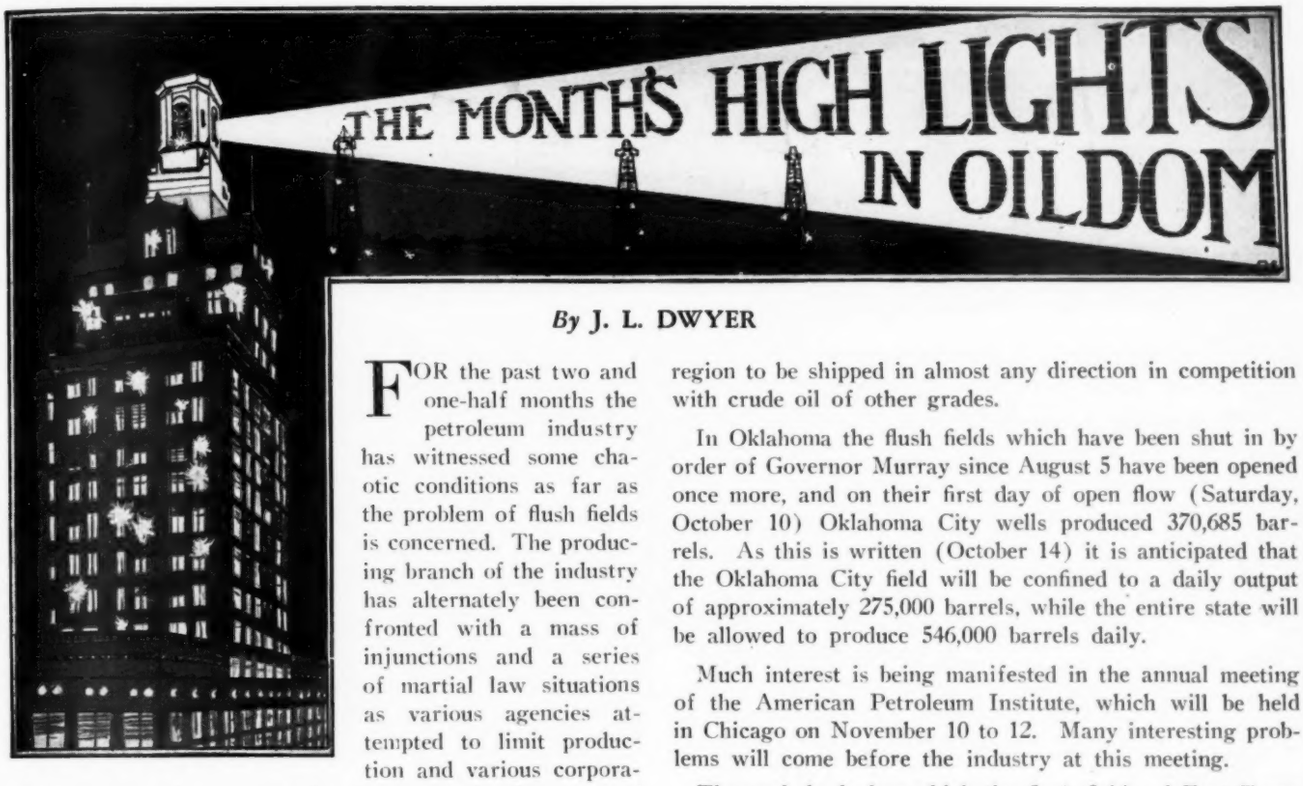


By **J. L. DWYER**

FOR the past two and one-half months the petroleum industry has witnessed some chaotic conditions as far as the problem of flush fields is concerned. The producing branch of the industry has alternately been confronted with a mass of injunctions and a series of martial law situations as various agencies attempted to limit production and various corporations attempted to ascertain the exact legal status of proration. Now that the smoke of battle has, to some extent, cleared away, it seems probable that through orderly meetings and programs which omit the spectacular, some order may be brought out of the chaos.

The great East Texas fields are still the most important spots in the industry, and it is believed that as long as the combined output of these great pools is held to under 400,000 barrels daily, little danger will result. With the completion of additional pipe line facilities from East Texas to the Gulf Coast, more crude will be moved in that direction. The geographical position of the East Texas fields is a very important factor, and permits the crude from this region to be shipped in almost any direction in competition with crude oil of other grades.

In Oklahoma the flush fields which have been shut in by order of Governor Murray since August 5 have been opened once more, and on their first day of open flow (Saturday, October 10) Oklahoma City wells produced 370,685 barrels. As this is written (October 14) it is anticipated that the Oklahoma City field will be confined to a daily output of approximately 275,000 barrels, while the entire state will be allowed to produce 546,000 barrels daily.

Much interest is being manifested in the annual meeting of the American Petroleum Institute, which will be held in Chicago on November 10 to 12. Many interesting problems will come before the industry at this meeting.

The periods during which the flush fields of East Texas and Oklahoma were shut in caused a sharp withdrawal of crude oil and refined products from storage, according to the most recent report of the U. S. Bureau of Mines, which shows that on the first day of September there was approximately 100,000,000 barrels of empty oil storage in the nation. Stocks of crude oil on September 1 were almost 14,000,000 barrels less than on August 1 and refined products showed a decrease of 2,000,000 barrels during the same period. Should a condition of this sort remain in the industry for any appreciable period it might afford us an excellent opportunity to take a better gauge on our potential production.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending October 3, 1931

(Figures in Barrels of 42 Gallons)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	473,300	74.7	3,772,000	10,819,000
Appalachian	91.8	107,400	78.2	1,285,000	1,628,000
Ind., Ill., Ky.	98.9	319,400	74.0	3,641,000	4,994,000
Okla., Kan., Mo.	89.6	245,700	56.5	2,808,000	5,003,000
Texas	91.3	516 200	67.4	5,207,000	11,607,000
Louisiana - Arkansas	98.9	161,300	70.0	824,000	3,442,000
Rocky Mountain	89.3	44,200	31.1	1,221,000	800,000
California	96.5	423,400	48.1	*11,610,000	97,287,000
Total Wk. Oct. 3	95.0	2,290,900	62.7	30,368,000	135,580,000
Total Wk. Sept. 26	95.0	2,355,600	64.4	30,773,000	135,820,000
Total Oct. 4, 1930	95.4	2,391,700	67.2	†34,894,000	140,451,000
The Texas and Louisiana Gulf Coastal figures shown below are included above in the totals of their respective districts.					
Texas Gulf Coast	99.8	408,300	76.8	3,939,000	8,270,000
La. Gulf Coast	100.0	110,000	74.6	601,000	2,486,000

Daily Average Production

(Figures in Barrels)

	October 3, 1931	August 29, 1931	October 4, 1930
Oklahoma	273,500	265,850	558,450
Kansas	107.250	99,550	115,950
Panhandle Texas	64,200	59,000	78,800
North Texas	53,900	55,150	64,450
West Central Texas	25,400	23,150	48,450
West Texas	199,000	206,050	269,800
East Central Texas	57,250	53,950	42,650
East Texas	381,400		
Southwest Texas	55,300	58,750	98,000
North Louisiana	29,200	29,650	39,900
Arkansas	37,600	37,300	53,150
Coastal Texas	121,000	129,000	166,350
Coastal Louisiana	29,750	23,500	29,900
Eastern (not including Mich.)	110,150	101,750	114,000
Michigan	13,450	9,900	7,850
Wyoming	36,550	38,000	52,000
Montana	7,450	7,900	8,950
Colorado	4,300	4,000	4,300
New Mexico	43,100	43,300	47,800
California	497,700	505,800	586,200
Total	2,147,450	1,751,550	2,386,950

† Revised in Indiana-Illinois district, due to transfer to "Bulk Terminals" of stocks previously reported as "At Refineries."

NOTE: In all the refining districts indicated except California, figures in this column represent gasoline stocks at refineries. In *California they represent the total inventory of finished gasoline and engine distillate held by reporting companies wherever located within continental United States (stocks at refineries, water terminals and all sales distributing stations, including products in transit thereto).

Difficult, Hazardous Conditions Overcome in

Drilling World's

DRILLING history has been made by the Penn Mex Fuel Company in reaching a depth of 10,585 feet in its Jardin No. 35 test well at Alamo, Vera Cruz, Mexico. This is the first hole in the world to be carried to a depth of two miles, an achievement in itself that would mark it as a worthy drilling feat. But the accomplishment is no mere worthy feat. It assumes added interest because of the many obstacles encountered that enormously increased the difficulty of drilling, and which might have brought about abandonment had there not been sheer determination to get the hole down to test the formations to the greatest depth possible.

Practically from the start the well was a tremendous hot salt water geyser, that for a while flowed daily 300,000 barrels of 162 degrees F. fluid. Another obstacle in drilling was the discovery of several horizons that carried noxious gases, injurious if inhaled by the crew. The location of the well was a natural handicap because of its distance from sources of supply and the rough, rugged country made transportation of equipment a difficult matter.

The greatest quantity of water was found at 3,200 feet. At 5,300 feet the 9⅝-inch casing was run to shut off the salt water flow, but 60 feet below the point and after the pipe was set, salt water was again encountered. This time the flow was 25,000 barrels daily.

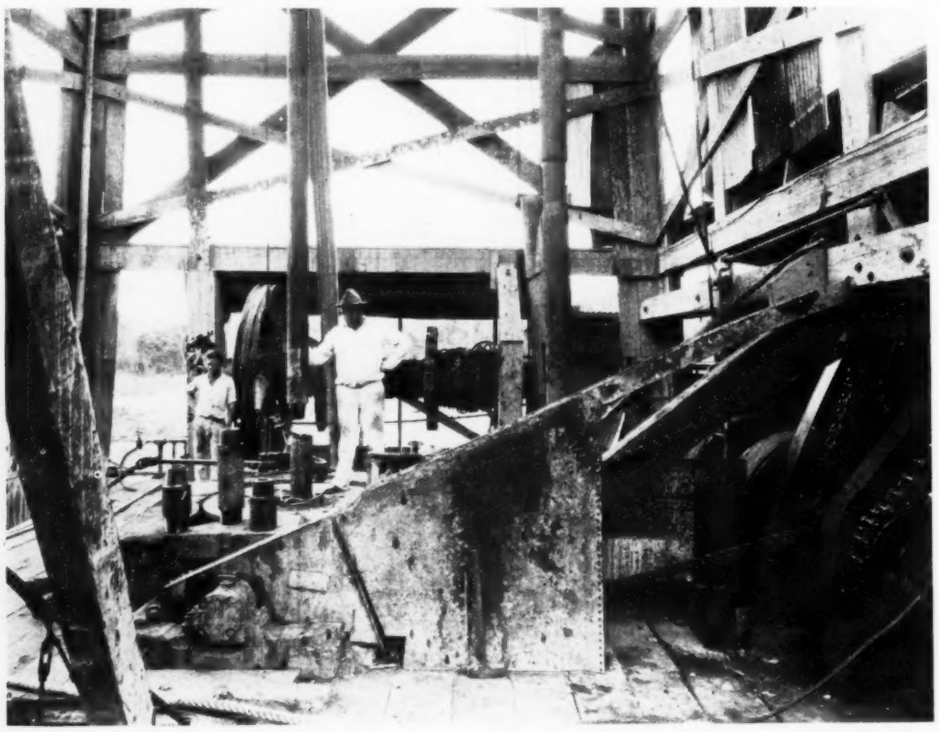
The enormous flow of salt water and great pressure required special hook-ups in order to continue drilling and several ingenious arrangements were installed. At one time the well got out of control and blew the drill pipe from the hole, resulting in a tragic accident. Thereafter, unusual care was taken in performing all rig operations, particularly in running in and out of the hole, when the chances of the well "going wild" were most apt to occur. The flow of hot salt water was quite detrimental to valves and other flow line connections, corroding them to the extent that they frequently had to be replaced.

THIS MONTH'S COVER

• On the front cover of this issue of THE PETROLEUM ENGINEER is reproduced an exceptionally impressive photograph of the radius bends on the aftercoolers of Cities Service Gas Co.'s Blackwell, Oklahoma, compressor station. The camera work was done by a member of the magazine's editorial staff and the treatment is not only unique but highly effective. » » » » » »

Before entering upon a discussion of the ways and means adopted to control the salt water output and permit drilling to continue, it would be well to explain the rig cellar construction. It is a rather unique affair, elaborate and of large size, affording ample room for the installation of adequate control valves and special equipment for handling the long string of drill pipe and devices for salt water control.

The 122-foot, 26-foot base, wooden, combination type rotary derrick rests on concrete corner bases that rise nine feet above the ground level. The corner base foundations are 6 ft. x 6 ft. and are supported on 10 ft. x 10 ft. by 3 ft. concrete mats. This gives the cellar a clearance of 9 feet above ground, which, with the below-ground pit and the sill clearance of 25 feet, gives it an over-all clearance of 36 feet. The cellar, with 14-inch reinforced concrete walls, has an inside dimension of nine feet by nine feet.



The rig floor of Jardin No. 35.

Special construction in the cellar gives support foundations for several equipment installations that are out of the ordinary. On the derrick floor is an ideal rotary table and other usual equipment, but at the ground level, or nine feet below the rig floor, a heavy I-Beam cross member serves as a foundation for a special spider that is practically a second rotary table, but only used as a support to hold the weight of drill pipe. The second table or spider is equipped with

Deepest Hole - - *Two Miles*

By **WARREN L. BAKER**

slips, interchangeable with those in use on the derrick floor table. The salt water flow kept the drill pipe constantly wet, resulting in a slippery, hard-to-handle condition, which together with the flush joint drill pipe design, made it necessary to have this two-slip drilling procedure hook-up as an extra protection against the possibility of drill pipe slippage.

Nine feet below the top I-Beam is another one that supports a large National double 6⅝-inch stuffing box. All drilling below 2,500 feet was done through this stuffing box, which serves to hold back the water and gas and to confine the flow to a 12-inch outlet line. Two extra heavy rubber rings are contained in the stuffing box and can be tightened or loosened separately by means of screw clamps. Beneath this stuffing box is a 14-foot nipple, attached at the upper end to the box and at the lower end to a 2,500-lb. test Kerotest drilling valve, which in turn is flanged to the 16-inch casing, which was hung on a Regan head. Immediately above this 16-inch drilling gate is an eight-inch valve, welded to a 16-inch bit nipple, an extra precaution against a blow-out.

THE accompanying interesting information on the skillful procedure that permitted drilling an 8 9/16-inch hole 10,585 feet, establishing a new world's deep record despite encountering perhaps the hardest drilling conditions ever found, was obtained from H. H. Reardon of H. H. Reardon Drilling Company, Tulsa, whose son, Jack, was a member of the crew. Mr. Reardon's brother, J. M. Reardon, is vice-president and general manager of Penn Mex Fuel Company and was directly in charge of drilling Jardin No. 35.

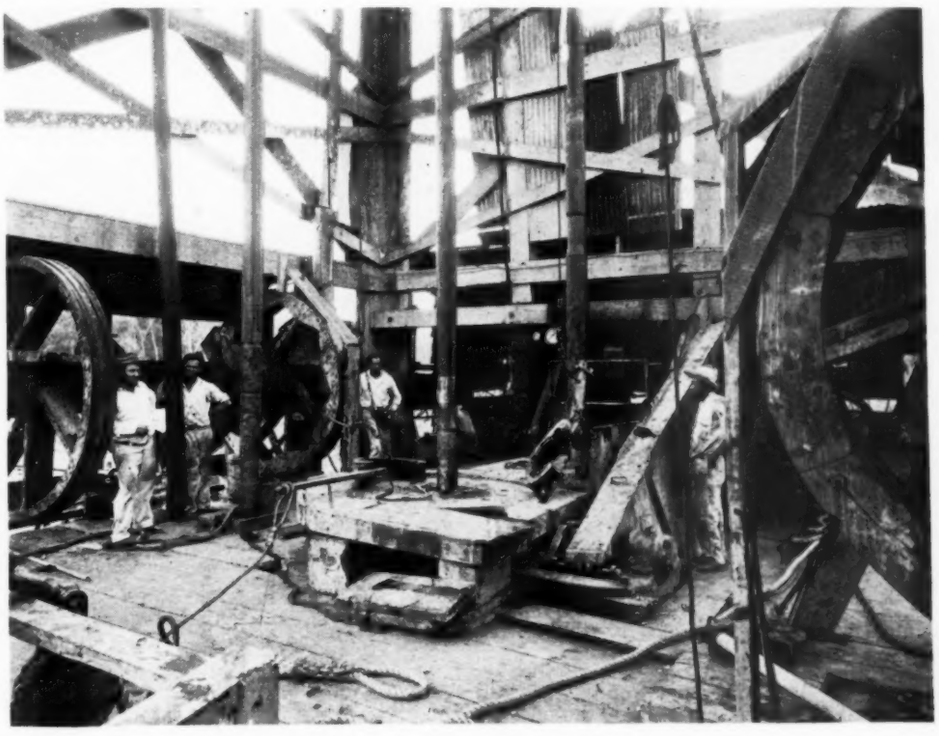
The only means of entrance to the cellar is a tunnel four feet wide and seven feet high, which extends from the cellar to a point about 100 feet away. It was necessary to put steps in the tunnel because of its slope to the bottom of the cellar. Through this tunnel two control arms project, each operating one of the lower drilling gate valves.

This cellar construction and equipment enabled the crew to handle the long strings of drill pipe with considerable safety and prevented the salt water blowing up on the rig floor. Whenever the drill pipe was being brought out of the hole it carried some of the hot water. This necessitated the rigging up of a shield to prevent it spraying on the crew.

Below 5,000 feet the reverse system of rotary circulation was put into use. Slush pumps were changed to pump against the salt water flow. With this system the circulation was down the casing and up inside the drill pipe. It was necessary to enlarge the holes in the drilling bits to accommodate a greater flow of water. The reverse system was a considerable improvement over the regular system of circulation in combatting the huge flow of salt water. With this hook-up it was necessary to dispense with rotary mud for maintaining circulation, and the reversed flow of salt water was used to clean the hole of cuttings.

An unusual arrangement of pipe fittings and flow connections was used to handle the salt water output and facilitate reverse circulation. A 12-inch line, tied into the casing string in the cellar, ran to the top of the cellar, thence out to the settling pits. This permitted flowing salt water into the pits; but since these would fill in 20 minutes by the enormous output, the line was equipped with a 12-inch gate valve and several smaller diameter by-passes so back pressure could be applied against the flow, thus reducing the amount of pump pressure required to maintain reverse circulation.

The salt water flow through the by-passes was regulated by opening the smallest line possible required to handle the output that the slush pumps could not control. This back pressure, combined with pump pressure, forced sufficient salt water to flow down inside the casing and up inside

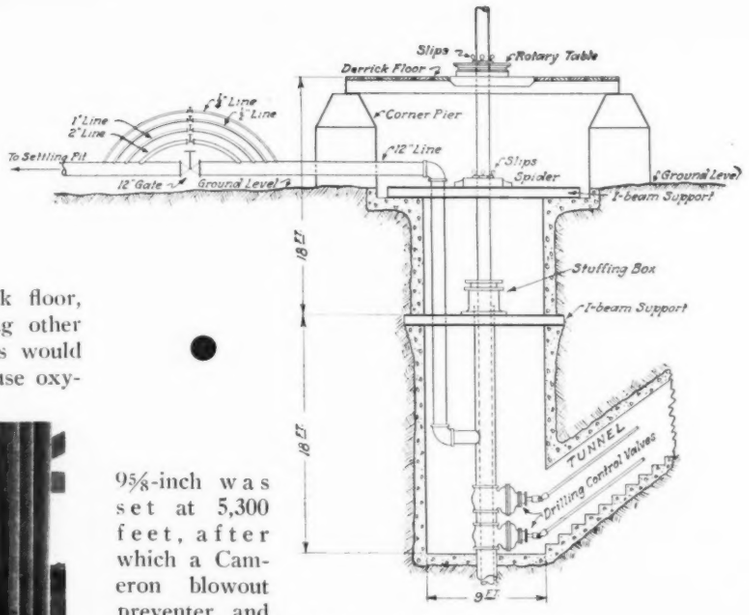


Another view of the rig floor with the drawworks in the foreground.

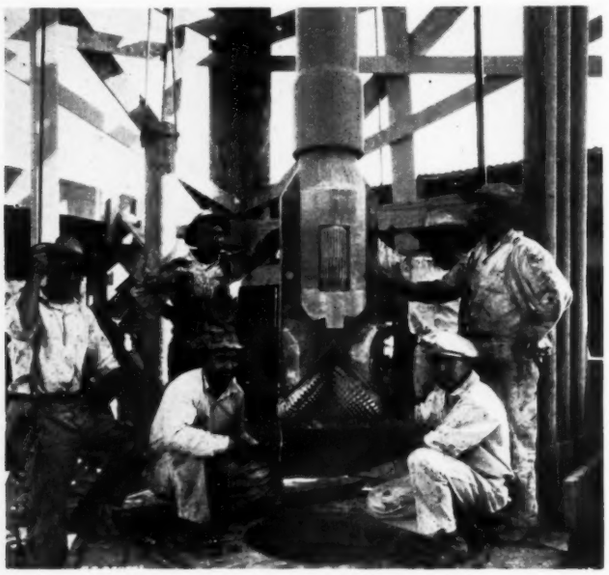
the drill pipe. The remainder of the salt water to the pits was confined to whatever size by-pass could accommodate the flow that the pump or pumps could not handle.

Most of the time the 12-inch gate valve was kept closed and the salt water flow by-passed through the smaller lines, of which there were four. The four lines were two-inch, one-inch, one-half-inch and one-quarter-inch in diameter, all equipped with control valves.

The noxious effects of the gas were especially noticeable while working below the derrick floor, when tightening stuffing box glands or performing other duties. Two or three deep inhalations of the gas would knock a man unconscious, making it necessary to use oxy-



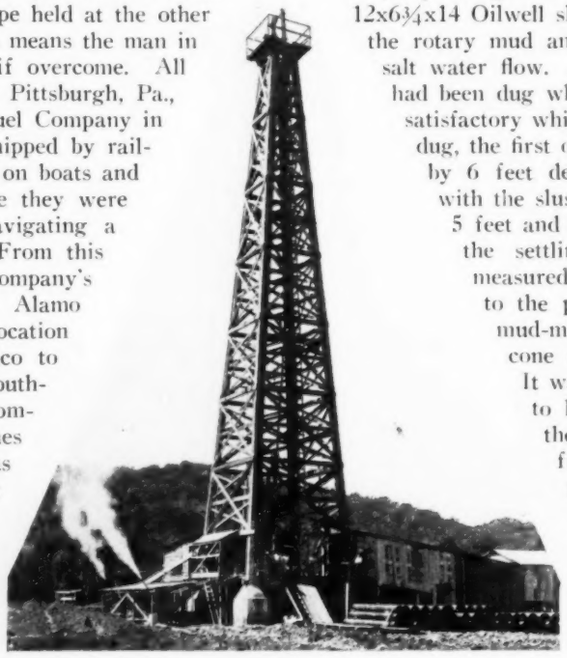
Cellar construction and hook-up.



Giant 22-inch bit that started Jardin No. 35 hole.

gen to revive him. Before a man went beneath the derrick floor the cellar was first steamed out to remove any gas accumulation. The crew also wore gas harness, which consisted of a large, heavy leather belt fastened around the waist line and an attached rope held at the other end by someone outside, by which means the man in the cellar could be dragged out if overcome. All materials for the well came from Pittsburgh, Pa., headquarters of the Penn Mex Fuel Company in the United States. They were shipped by railroad to New York, thence loaded on boats and taken to Tampico, Mexico, where they were reloaded on boats capable of navigating a long lagoon to Alvarez Camp. From this point they were carried over the company's own railroad 15 kilometers to Alamo Camp, thence by tractors to the location seven miles away. From Tampico to Alvarez Camp is 125 miles in a southerly direction. The hole was commenced with a giant 22-inch Hughes drilling bit. The 22-inch casing was set at 190 feet and cemented to the surface. The next string of casing, 16-inch, was set at 2,236 feet, followed by the 13½-inch at 2,735 feet, with a Baker cement shoe in use. Following the 13½-inch casing a string of 9⅝-inch was set at 5,300 feet, after which a Cameron blowout preventer and a 6,000-pound test valve were installed in the cellar. Regular 6⅝-inch, 25.20-pound drill pipe with couplings was used in the upper part of the hole, but after setting the 13½-inch casing, 6⅝-inch, flush-joint drill pipe was used to 5,300 feet, then 4½-inch drill pipe to 10,585 feet. A. Leschen and Sons Rope Company 1⅛-inch wire line was used, with National Supply crown and traveling block. In running drill pipe it was necessary to snub it into the hole because of the high pressure. In coming out the lower drilling gate valve was closed immediately after the bit had passed through and before it had passed out of the stuffing box. A Martin-Decker weight indicator was closely watched during all drilling operations.

Six 50-horsepower, 175-pound working pressure, Oilwell steam boilers were in use, although only four or five of these were required at a time to operate the rig. Natural gas from neighboring shallow wells was used as fuel. The drilling engine was an 11- by 11-inch Oilwell twin-cylinder one, operating a National-Ideal draw-works. Two 12x6¾x14 Oilwell slush pumps were used to circulate the rotary mud and later to pump against the hot salt water flow. A very elaborate mud pit system had been dug when the well was started and was satisfactory while in service. In all, five pits were dug, the first of which was the usual size, 20x20 by 6 feet deep. Two settling pits, connected with the slush pit by troughs, were 18x180 by 5 feet and 20x70 by 5 feet. On each side of the settling pits were reserve pits that measured 200x200 by 4 feet. In addition to the pits, other equipment to facilitate mud-mixing included a standard type cone mixer set on a cement platform. It was equipped with a small steam jet to heat the mud mixture and hasten the mixing. A mud plant, fabricated from two wooden tanks, was also near by. At the present time the hole diameter is 8 9/16-inch. The last 529 feet of hole was drilled in 10 days. The well is now shut down awaiting orders. A string of casing may be run and the hole deepened.



The rig that drilled the world's (August, 1931) deepest hole.

Drilling Problem Overcome When

Huge Crevice Is Bridged With Heavy Mud

THE manner in which Winkler & McQueen, drilling contractors, coped with an unusually large crevice in a well is an interesting feat of combating a difficult and baffling drilling problem. The situation arose when the contractors were drilling the Jim Cloud, Inc., and Dana Oil & Gas Company's Jones 1, in Section 169, Block 3, T. T. & N. O. survey, in the Sunray pool of Moore County, Texas.

They had drilled with rotary tools to 2,650 feet, where the eight-inch casing was set and cemented. Standard tools were used from this point down and the six-inch casing was being carried in the hole. A flow of gas estimated at 15 million cubic feet daily and with a rock pressure of 440 pounds per square inch was found at 2,850 feet and necessitated the carrying of 1,000 feet of water in the hole.

This was the condition of the hole when around 3,000 feet it was noticed that the tools began showing excessive wear on one side. At 3,050 feet all the water in the hole suddenly disappeared and the 15,000,000 cubic feet of gas, no longer confined by the hydrostatic pressure of the water, began blowing out the mouth of the casing.

A stream of water from a four-inch line was immediately turned into the hole, but the water continued to disappear and the gas flow was not killed. After some time this was abandoned and an attempt was made to continue drilling. The bit continued to wear on one side and often the tools would not touch anything; the cable apparently could be let out indefinitely without touching bottom. This condition led to the belief that the hole had been drilled into a large crevice.

A vain attempt to fill the crevice with water, mud, cement and other materials was conducted during the next ten weeks. Although it is not known how much water was actually run into the hole, it was estimated to be in excess of 300,000 barrels. In addition to the water, 10,000 barrels of mud was pumped in; also, 2,000 feet of wire line cut into three-foot lengths and 600 pounds of scrap iron were dropped into the hole, and all disappeared. Following this, 1,800 sacks of cement were dumped into the hole with similar results. The gas continued to blow unabated during this time.

It was finally decided to try to bridge the crevice rather than attempt to fill it. A thick commercial mud in the form of a paste, so as to be strong enough to support enough cement to block off the lower portion of the crevice and make necessary only the filling of the upper part, was prepared and pumped into the hole at intervals of 24 hours for four days. The first batch stopped the gas flow and enabled the fluid level to be held about 1,000 feet from the bottom of the hole. The other batches made no change in the fluid level.

Each batch consisted of 400 barrels of water and 150 sacks of Aquagel (10 per cent Aquagel by weight), with which was mixed 4,000 pounds of cottonseed hulls. After the fourth batch, 50 sacks of cement was pumped into the bottom of the hole, in hopes that the crevice had bridged sufficiently for the cement to form a permanent bridge. After setting for several days the cement was drilled out and gas broke through again.

Winkler & McQueen at this time began studying other ways and means of overcoming the difficulty, but it was finally decided to continue with the commercial mud and cottonseed hulls. About 2,000 paper mud and cement sacks were crumpled up and rammed down the hole, following which 16 batches of the thick mud, having a consistency of vaseline, each containing 400 barrels of water, 150 sacks of mud and 1,400 pounds of cottonseed hulls, were pumped into the hole. The pressure rose to such a point that it was felt reasonably certain a bridge had been formed across the crevice. Two hundred sacks of cement were then pumped into the hole, leaving the top of the cement plug about 20 feet above the bottom of the hole.

After allowing the cement to set for several days, it was drilled out when it was found that the difficulty had been completely overcome, thus enabling drilling to be resumed. Thirty days later the well was completed at a depth of 3,470 feet and produced 500 barrels of oil on the first day.

This is believed to be one of the largest crevices ever encountered in drilling an oil test. Its size is clearly indicated by the amount of materials that disappeared and by the large amount of mud required to bridge across it. Not including the water, the materials used in plugging up this cavern would occupy a volume of approximately 200,000 cubic feet, or a room five feet wide, 100 feet long and 400 feet deep. Since undoubtedly only a small portion of the crevice was filled with this material, the probable size and shape, whether it was a long, narrow and deep crevice or a cavern similar to those known to exist in many parts of the country, can only be left to conjecture.

The last batch of mud being prepared for injection into the hole.

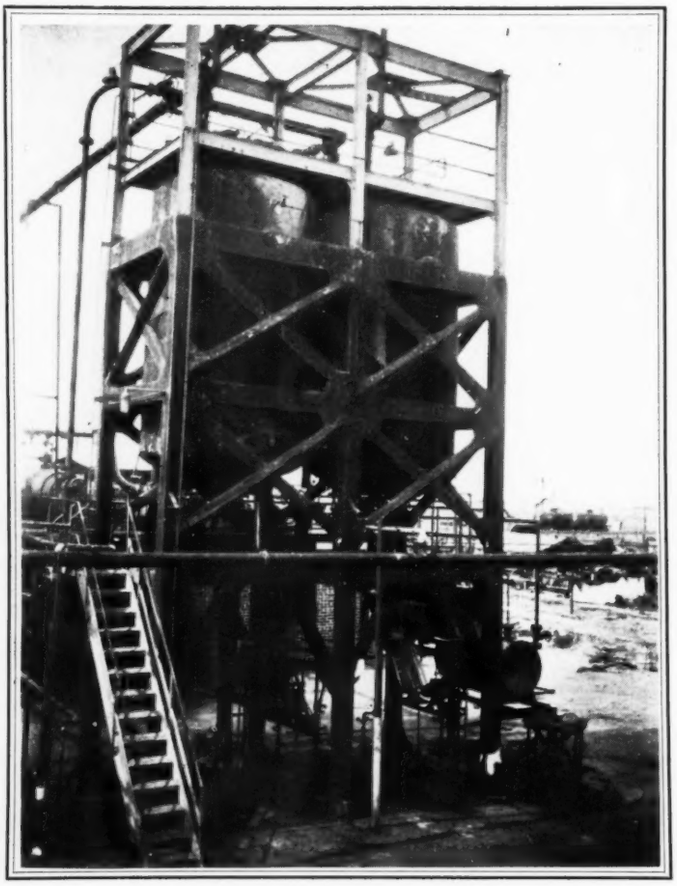
Vapor Phase Treating *of* Cracked

By GEORGE PFAU *and* C. A.

CRACKED gasoline, when properly refined, has taken its place as one of the most satisfactory motor fuels of the present time. This is because the product usually has a high anti-knock rating and therefore gives satisfactory performance in the present high compression automotive engines. Even though a sufficiently high detonation value of this product is not obtained, the fact that it will, in most cases, require less treating than straight run gasoline to bring it to a satisfactory standard, is of itself very important from the refiner's viewpoint, as it materially lowers his blending cost or may make possible the blending of his straight run fuel with Ethyl fluid, in cases where this straight run gasoline would require more tetraethyl lead than is allowable.

So cracked gasoline has gradually changed from a product that formerly had to be blended secretly with straight run gasoline in order to dispose of it, to one that has become a leader, often selling at a premium. This is due to the recognition of its superior power and anti-knock properties which are mainly due to those unsaturated and aromatic compounds that were formerly believed to be undesirable.

Improperly refined cracked gasoline can be used as a motor fuel only at the expense of gummed valves, excessive carbon deposits, and other ills which make its use undesirable. It rapidly loses color on exposure to light, darkens in the glass bowls of pumps, and may even darken considerably in storage. This feature of unstability of color is usually characteristic of improper refining and generally could be overcome only at a great sacrifice of the detonation value of the product, which usually embraces treatment of the raw distillate with chemicals, and a subsequent re-running operation. There are many gasolines produced in the raw state with exceptionally high anti-knock values and this property is then considerably reduced by the necessary treatment which follows in converting the raw material into a finished product acceptable to the trade; and this final treatment is necessary to insure color stability and good odor and usually ignores the effect upon the detonation value of the gasoline. These undesirable characteristics are generally caused by a very small percentage of extremely unstable substances.



Gray Towers at T. P. Refinery.

Many refiners have been using for several years the process of vapor phase treatment as the means of accomplishing the removal of this small percentage of undesirable compounds. The process is known as the Gray Vapor Phase Process and has been developed and licensed by the Gray Process Corp. The process has been successful in producing a highly satisfactory refined motor fuel from gasoline produced from many different grades of cracking stocks and from various types of cracking processes, in a very satisfactory manner. It removes the small percentage of undesirable compounds with practically no decrease in the anti-knock value of the finished gasoline from that of the raw product at a low cost.

The theory of the process is simple; the catalytic action of clays, such as fuller's earth, has been known for a considerable period of time. In vapor phase refining, it causes polymerization of the objectionable unstabilized hydro-carbons existing in the vapor form. These are the materials which ordinarily change to gums on standing in storage. By this process they are immediately changed to compounds known as polymers, and because of their high boiling point they can be separated as liquids from the other vapors. These polymers are usually of a dark brown cast and on exposure to air gradually harden into gum, having the appearance of shellac. A typical test of them follows:

Gravity	45.1° A. P. I.
I. B. P.	180
90 Per Cent	426
E. P.	554
Mg Gum (100cc)	1860
Unsaturates	1490

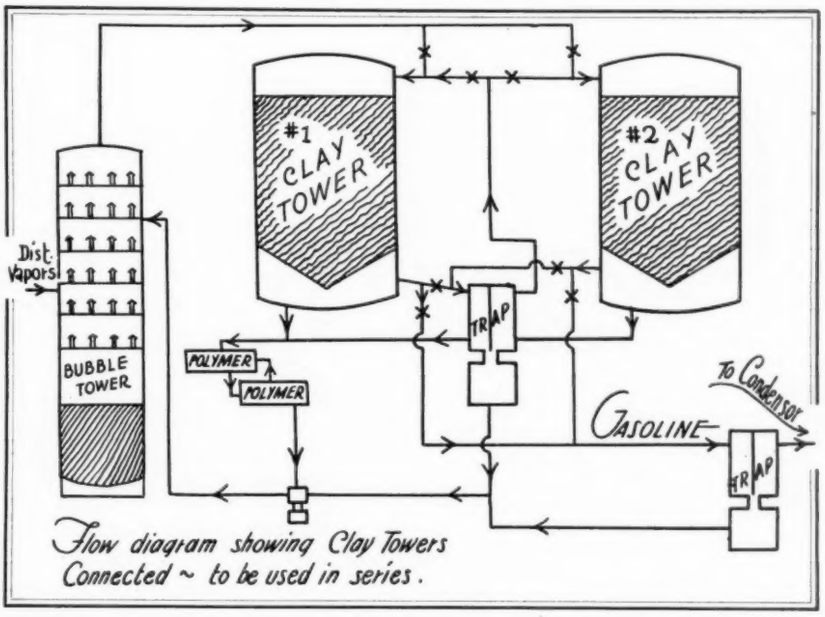
Polymers contain a large percentage of gasoline and they are therefore fed back into the fractionating column, where the heavier ends are gradually condensed and enter the cracking coils along with the recycle stock. Polymers themselves on cracking usually produce a gasoline of

Distillate *at* T. P. Refinery

BARRERE, *T. P. Coal and Oil Co.*

high anti-knock value. However, by the use of a separate tower, this material can be refractionated and the polymers thus separated and disposed of as a by-product.

The equipment necessary for an installation consists of one or more cylindrical tanks charged with fuller's earth, or other suitable clay, supported on a false bottom which will allow vapors and liquids to pass. These towers are well insulated in order to prevent the condensation of excessive amounts of gasoline. They are so connected that the vapors enter at the top of the clay tank and pass down through the clay where the polymerization takes place. Beneath the false bottom is a chamber in which the liquid drops out of the vapors and passes by gravity to a small tank, from where they may be pumped to the most desirable part of the system. The vapors leave through an outlet near the upper part of this chamber and should pass through a trap or small bubble tower, so that if any polymers are entrained with the gasoline vapor, they may be separated.



Flow diagram showing Clay Towers Connected ~ to be used in series.

The design of the installation may be varied somewhat due to the particular need of the refiner using it. Some recent tests have shown the tendency of that process to be more efficient as the pressure is increased. Also larger diameter clay towers have given better results. One unusual but successful hook-up is made whereby the towers are connected in series.

The accompanying flow diagram shows this particular arrangement. Originally, the towers were connected so that one was used while the second was out of service, but owing to the fact that the towers were entirely too small for the amount of gasoline produced, they were so connected that they could be run either in parallel or in series. It was found that series operation produced by far the better results both as to gum content of the gasoline and the life of the clay. A polymer trap was installed between the two towers so that entrained polymers could be separated and would not enter the second tower. The gasoline also passed through a trap after leaving the final tower. Further, the towers are so connected that either tower may be placed as the first or last one in the system. This allows the maximum efficiency to be obtained from the clay, because of the fact that even when the first tower may not be producing a gasoline with a sufficiently low gum content, though the color may be 30 plus, the second tower containing fresher clay will clean the gasoline and reduce the gum content to a satisfactory limit. Then, in turn, when the final product runs high, the oldest tower can be dumped and recharged with fresh clay and then made the last tower in the system. As much as 4,000 additional barrels of gasoline per ton has been put through in this manner.

The particular kind of clay to be used is a problem for each refiner. Clay from many different sources are used. A clay of 30/60 mesh was found to give the best results. The life of the clay is affected naturally by the type of cracking stock used and the type of operation. It may be prolonged by washing or spraying the clay with gasoline or by steaming during shut down periods or at intervals. The yield of gasoline per ton of clay varies from 1,000 to 12,000 barrels of gasoline, although some towers have shown considerably higher yields. Some difficulty has been experienced with the screens, which support the clay, through plugging, especially after the tower has been subjected to many steamings. The average life of the screens is probably from 18 months to two years.

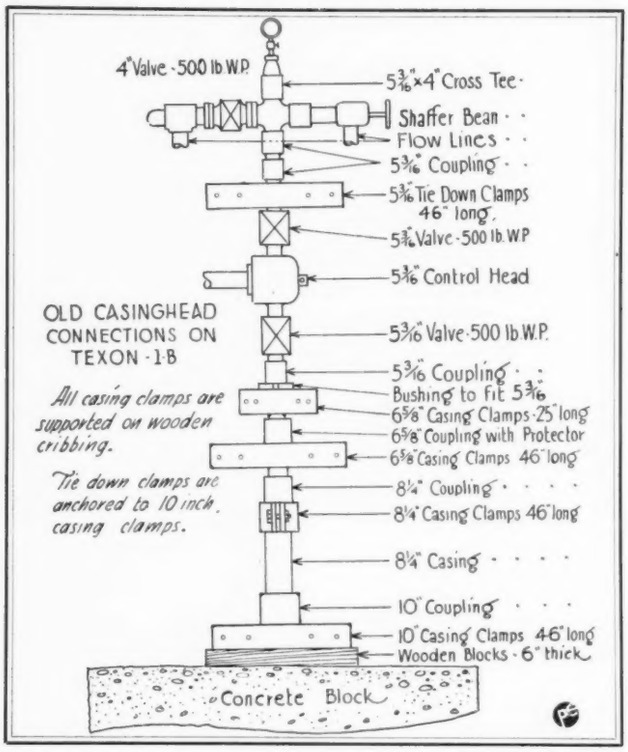
As most refiners ordinarily think in terms of acid treating when discussing the treatment of light oils, it is therefore natural that one should ask how this method compares with acid treating. Therefore a few advantages of the Gray Process are given:

1. Elimination of rerunning in installations where it is practical to take a test gasoline from the Cracking Unit.
2. Very small loss or none at all.
3. Simplicity of installation and operation.
4. Removal of undesirable constituents without affecting the detonation value of the gasoline.
5. Minimum tankage investment required.
6. Economical method of operation.
7. Minimum cost of maintenance and repair.

These points are self-explanatory and very little needs to be said regarding them. In regard to cost, suffice it to say that the method shows a low cost per barrel of gasoline, which makes the process very attractive to the refiner.

Deep Discovery Well in Big Lake Field "Killed" to Make Repairs

By K. C. SCLATER


4" Valve - 500 lb W.P.
5 3/16" x 4" Cross Tee
Shaffer Bean
Flow Lines
5 3/16" Coupling
5 3/16" Tie Down Clamps 46" long
5 3/16" Valve - 500 lb W.P
5 3/16" Control Head
OLD CASINGHEAD CONNECTIONS ON TEXON - 1-B
5 3/16" Valve - 500 lb W.P.
5 3/16" Coupling
Bushing to fit 5 3/16"
All casing clamps are supported on wooden cribbing.
6 5/8" Casing Clamps - 25" long
6 5/8" Coupling with Protector
6 5/8" Casing Clamps 46" long
Tie down clamps are anchored to 10 inch casing clamps.
8 1/4" Coupling
8 1/4" Casing Clamps 46" long
8 1/4" Casing
10" Coupling
10" Casing Clamps 46" long
Wooden Blocks - 6" thick
Concrete Block

PRODUCTION has been temporarily suspended in the deep discovery well in the Big Lake field, University 1-B, Group No. 1 Oil Corporation. The well was killed September 17, by running tubing under pressure to bottom and mudding off the face of the sand. It is planned to renew the casing and replace the low pressure fittings so that high back pressures can be carried on the well if such are found necessary to obtain a reduction in the gas-oil ratio. For it is reduction of gas-oil ratio in the deep wells in the interests of gas conservation and to conform with state regulations that has prompted the owners of the well to put it in proper condition at this time.

This well has a remarkable production record, having produced continuously and consistently since the day it was completed in December, 1928. Its total production to date is approximately two and a half million barrels of oil, an average daily rate of production of 2,500 barrels from December, 1928, to September 17, 1931. Just before the well was killed the average daily rate of production was 2,200 barrels oil and 15 million cubic feet gas. This is a gas factor of 6,800 cubic feet per barrel, a comparatively low gas-oil ratio for a deep well in this field.

Coming in somewhat unexpectedly in the 8,500-ft. sand, with high gas pressure and large volume, the well was immediately placed on production. The casing and fittings on the well were not disturbed. It was allowed to produce without any restriction or without making any changes other than applying a slight back pressure of 185 pounds at the casinghead.

At the time of completion, the oil string, consisting of 6,176 feet of 5 3/16-inch 20-pound casing, was known to be badly line-cut. It had been lowered from its original position at 3,100 feet by reaming during the time the well was deepened. From 6,176 feet on down the well was drilled through the 5 3/16-inch casing with cable tools to a depth of 8,523 feet, establishing a record at that time for deep drilling depth and also for deep production by natural flow. The casing record on the well at completion was: 769 feet of 15½-inch casing, 1,820 feet of 12½-inch, 2,590 feet of 10-inch, 2,825 feet of 8¼-inch, 3,080 feet of 6⅝-inch, and the 6,176 feet of 5 3/16-inch casing. Below the 5 3/16-inch casing there was 2,347 feet of open hole.

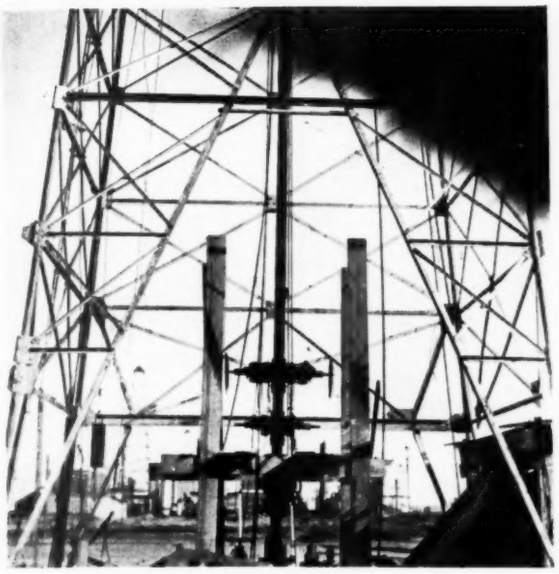
A difficulty was presented with this control head. It had been left open only two-thirds by the original operators of the well. In this position it rusted and could not be opened or closed.

Surface preparations for killing the well consisted of erecting a steel derrick and installing a complete heavy draw-works with mud pumps at the well.

No attempt had been made to replace the low pressure fittings on the well because the 5 3/16-inch casing was badly line-cut and also the top coupling had been welded on the pipe. There was nothing to be gained by putting high pressure valves on such a weakened string of casing.

The next larger size casing in the hole, the 6⅝-inch had been set at 3,080 feet, but had not been packed off with a bradenhead from the 5 3/16-inch. Because of the low pressure casinghead connections and the welded coupling on the line-cut casing, the hazard involved in lifting the 5 3/16-inch casing was altogether too great to risk attempting it. So, save for opening the control head, the original connections were not disturbed when preparation were made for running tubing in the well to kill it. The badly corroded control head was opened with tongs and the aid of the cathead, but before

Starting to dismantle control equipment used for running tubing in well under pressure. Big Lake field, Texas.



Lubricator for starting tubing in well.

this was attempted the casinghead was thoroughly braced vertically and laterally and the control head given a thorough soaking in a bath of penetrating oil. Even with these precautions, there was grave danger of breaking off the casinghead connections in opening the control head.

With the control head full open, the upper 5⅛-inch gate valve was then closed. This forced the well to produce through the side outlet of the control head (see sketch). The plug in top of the 5⅛-inch by 4-inch dross was replaced with a gate valve. On the gate valve was placed the regular installation of three Cameron control heads as used by the Southern States Company, who had the job of running the tubing. Full details of this equipment and its use in running tubing under pressure are given in an article on page 29, December, 1930, issue of THE PETROLEUM ENGINEER. This installation of control heads was surmounted by a lubricator seven inches in diameter and 30 feet long.

A perforated joint with a Womack valve was run on the bottom of the string of tubing making it necessary to use the lubricator.

While the tubing was being run the well was produced against a casing pressure of 160 pounds per square inch, which was regulated by an adjustable flow bean.

About 500 feet (17 joints) of tubing was snubbed into the hole. Thereafter the weight of the tubing itself was sufficient to lower it into the hole.

By the time all the tubing was in about 2,500 sacks of El Paso clay had been prepared in the slush pit. This amount of mud filled a pit 100 feet by 20 feet by 8 feet deep. It was mixed to a consistency of 12-13 pounds per gallon by means of a cone type mixer of the Loffland Bros. Drilling Company.

On September 17, at 3 p. m. mud was started down the tubing. In half an hour the well was killed. Its demise was sudden and complete. It appeared as if quite a head of mud had accumulated in the tubing before the Womack valve on the bottom of the tubing opened and that this caused the mud to be suddenly shot from the tubing into the bottom of the hole, thus cutting off the flow of oil and gas from the producing sand.

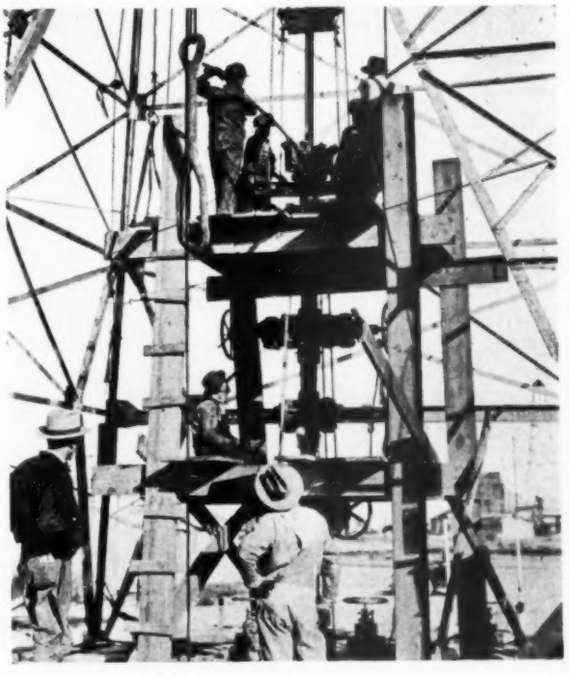
The mud pumps, 14½ by 6½ by 18, run along at top speed—50 strokes per minute—without any resistance until the head of mud in the tubing and in the casing were equalized. The pump pressure then started to increase. When circulation was established the pump pressure was maintained at 1,000 pounds per square inch. All this time the two flow lines on the Christmas tree (see sketch) were left open.

One significant fact was observed in regard to the production while the tubing was being run. During the time the tubing was being run to 3,000 feet the daily well production rate fell off about 100 barrels oil and three million cubic feet of gas. After the tubing had reached 3,000 feet no change in the rate of production took place. Every precaution had been taken in the preparations to avoid increasing the pressure unduly in the weakened 5⅛-inch casing. In the upper part of the string pressures were successfully kept low. The pressures in the lower part of the casing string, however, were probably quite high in the final stages of running and tubing. The fact that no change in the rate of production was observed when the tubing got below 3,000 feet was a good indication of the importance of proper tubing design for deep wells of large oil and gas production as found in this field. It also indicates that the pressures in the lower section of the 5⅛-inch casing were inadvertently increased a probable dangerous amount. To what extent is not known.

Circulation was lost about 6 p. m., 2½ hours after the well had been killed. For two hours, strenuous efforts were made to re-establish circulation, but to no avail. To obviate the possibility of planting the tubing, it was then raised 2,000 feet. This job took about six hours. The mud was then thinned up to 9-10 pounds per gallon and circulation was soon restored.

Circulation and mudding up the well continued until Monday, September 21, after which time the tubing was pulled.

Since pulling the tubing, attempts have been made to free the casing. A pull as great as 134,000 pounds was taken on the casing. Beyond taking a stretch of six feet the casing did not budge. At this writing preparations are being made to cement the lower 500 feet of hole. When the cement has set the casing will then be removed by cutting and pulling, if necessary. With the face of the producing sand cemented the hazard of the well blowing out has been entirely eliminated.



Snubbing in tubing under pressure.

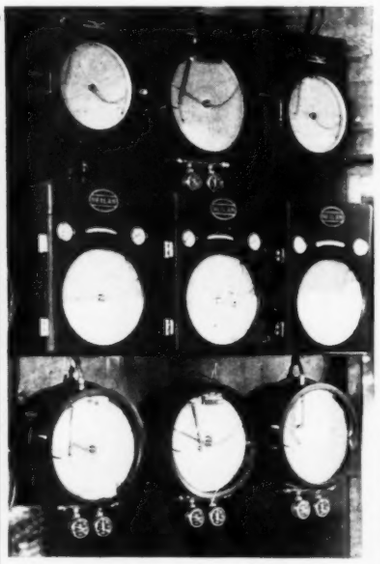
New Stabilizing *and* Recovery Plant *in* West Tulsa Refinery

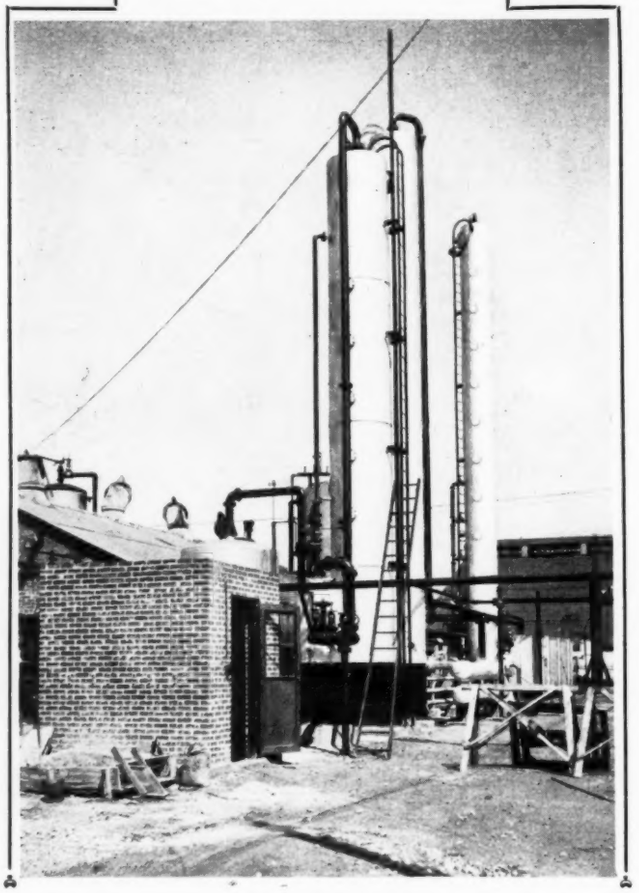
By F. R. STALEY

A CONSTRUCTION program was recently completed at the West Tulsa refinery of the Producers & Refiners Corporation. In addition to a new brick building housing the testing and research laboratories, two new refinery units were built in the plant by the Burrell-Mase Engineering Company of Pittsburgh, Pa. These units consist of a pressure distillate stabilizer and a combination recovery and stabilizing plant.

During the past year most refiners have installed stabilizing equipment in order to produce motor fuels free from propane and dissolved gas from their cracking units. Vapor pressure is now considered one of the important specifications of gasoline along with the anti-knock rating or octane number.

The Producers' & Refiners' plant is one of the most modern in the state of Oklahoma, and is equipped to manufacture high quality motor fuels from Mid-Continent crudes. John Cutter is superintendent of the refinery and M. H. Nolan is his assistant.





(Above) Stabilizer control instruments, Producers & Refiners plant. (Below) Gas absorption and stabilizing plant, Producers & Refiners.

The flow diagram shows the operation of the stabilizing units and the recovery plant. The pressure distillate stabilizer is installed beside the cracking units. It has a capacity of 3,000 barrels of raw distillate per day. The distillate is produced by two Dubbs units in a non-residuum operation. These units have a capacity of 1,200 barrels per day each, charging reduced crude of approximately 26 A.P.I. gravity.

The pressure distillate stabilizer consists of a bubble tray tower, four feet in diameter and 51 feet high. The raw pressure distillate first enters a receiving tank under about 60 pounds pressure, and is fed to the stabilizing column through a Griscom-Russell heat exchanger and steam preheater. In the heat exchanger it is heated by the stabilized distillate from the bottom of the tower. The tower is operated under a pressure of about 35 pounds per square inch. The operation can be so regulated as to produce a product of the desired vapor pressure. The stabilized distillate leaves the bottom of the tower through the heat exchangers and a cooler on its way to storage. A reflux pump is used to pump open reflux over the tower from the accumulator tank which maintains the desired vapor temperature.

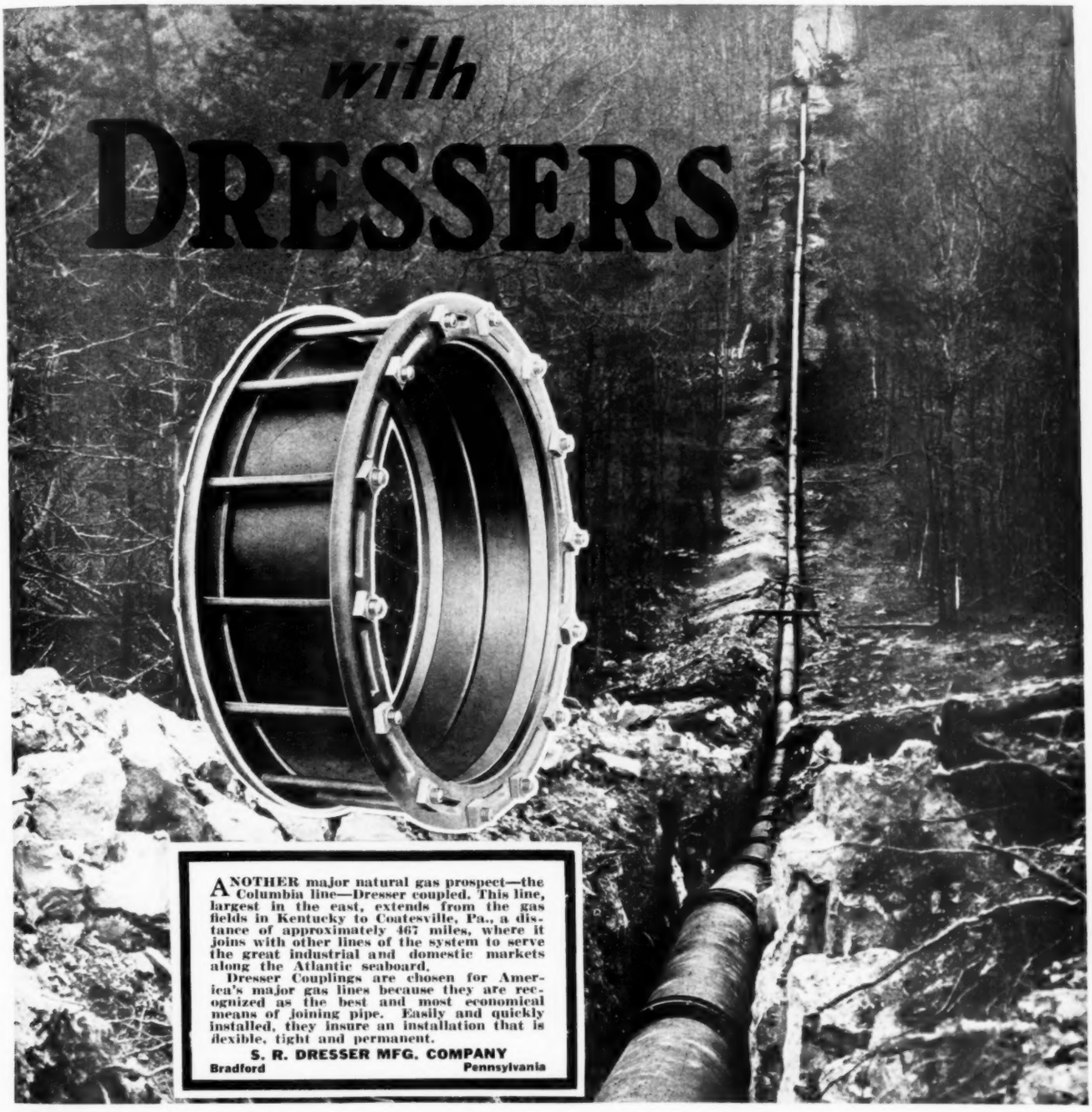
Automatic control and recording instruments make the operation of the stabilizer automatic. A Westcott proportional volume controller controls the feed and the reflux to the tower.

The overhead distillate from the pressure distillate stabilizer is delivered under its own pressure to a surge tank located at the final stabilizer in the gasoline recovery plant. The recovery plant consists essentially of a 60-horsepower, two-cycle, Clark compressor, an absorption tower and a distillation unit. A final high pressure stabilizer treats the recovered distillate together with the overhead from the first unit.

The absorption tower is 51 inches in diameter and 40 feet high. It is a bubble plate type. The compressor draws the gas from the crude distillation unit, the run down and storage tanks, and the rerun stills. It discharges the gas under 30 pounds pressure through a scrubber to the absorber. Light kerosene distillate from the crude is used as the absorption oil. The fat oil is distilled in the distillation unit, and the overhead from the accumulator goes to a surge tank where it mixes with the overhead from the pressure distillate.

This material in the surge tank is charged to the final stabilizer by means of Dean simplex steam pumps which are designed to handle very volatile liquids. Before entering the column the feed passes through a heat exchanger and a steam preheater. The working pressure on the stabilizer is from 185 to 200 pounds per

From Kentucky to the Eastern Markets



ANOTHER major natural gas prospect—the Columbia line—Dresser coupled. This line, largest in the east, extends from the gas fields in Kentucky to Coatesville, Pa., a distance of approximately 467 miles, where it joins with other lines of the system to serve the great industrial and domestic markets along the Atlantic seaboard.

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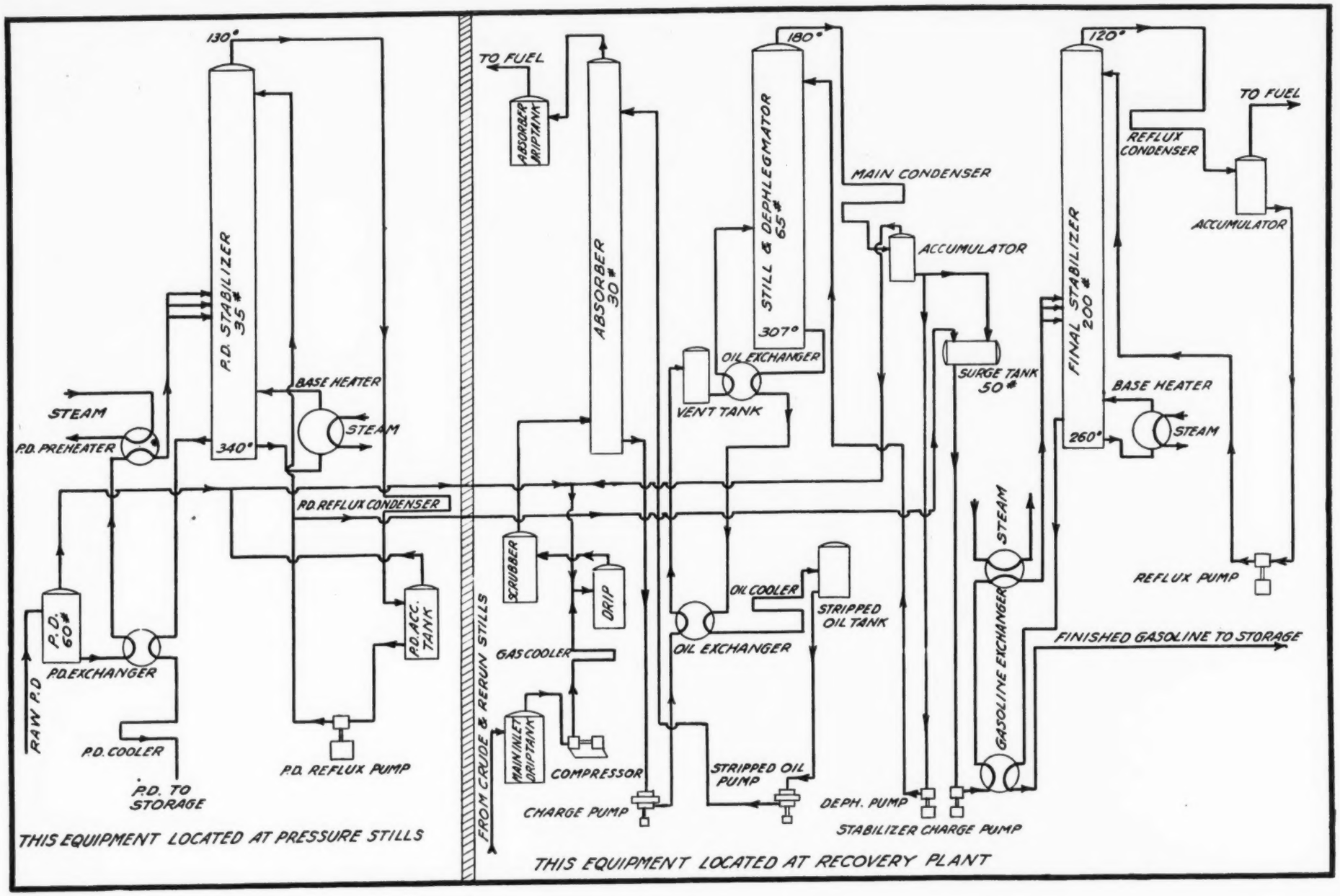
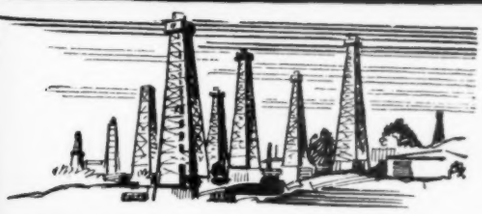
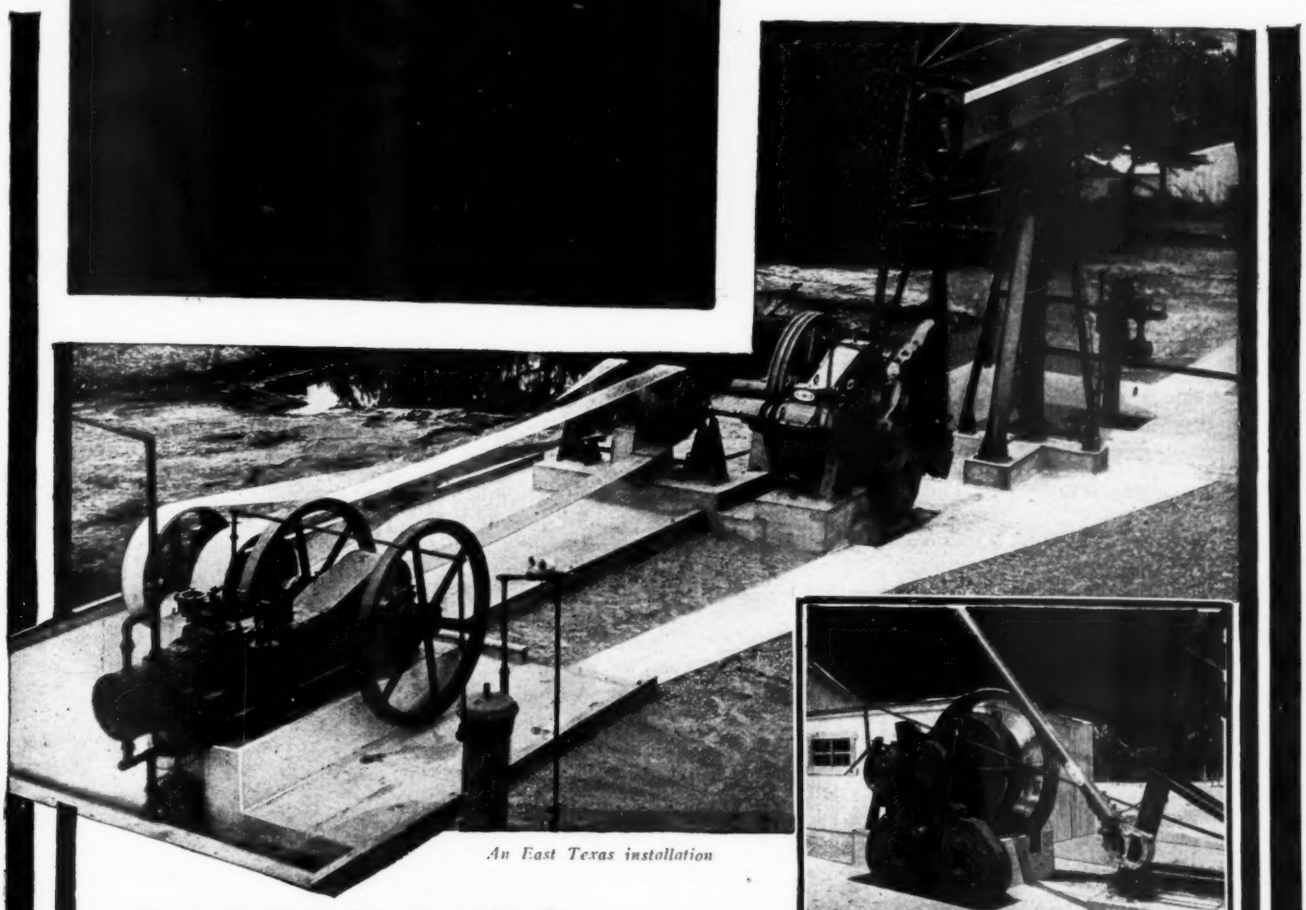
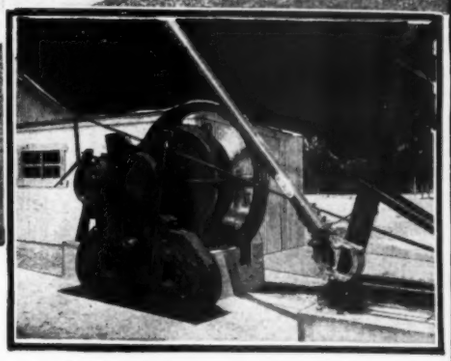

130°
P.D. STABILIZER 35#
340°
BASE HEATER
STEAM
STEAM
P.D. PREHEATER
P.D. REFLUX CONDENSER
P.D. 60#
P.D. EXCHANGER
P.D. ACC. TANK
RAW P.D
P.D. COOLER
P.D. TO STORAGE
P.D. REFLUX PUMP
THIS EQUIPMENT LOCATED AT PRESSURE STILLS
FROM CRUDE & RERUN STILLS
TO FUEL
ABSORBER DRIP TANK
ABSORBER 30#
SCRUBBER
DRIP
GAS COOLER
MAIN INLET DRIP TANK
COMPRESSOR
CHARGE PUMP
180°
STILL & DEPHLEGMATOR 65#
307°
OIL EXCHANGER
VENT TANK
MAIN CONDENSER
ACCUMULATOR
OIL COOLER
STRIPPED OIL TANK
OIL EXCHANGER
STRIPPED OIL PUMP
DEPH. PUMP
SURGE TANK 50#
STEAM
GASOLINE EXCHANGER
STABILIZER CHARGE PUMP
120°
FINAL STABILIZER 200#
260°
REFLUX CONDENSER
TO FUEL
ACCUMULATOR
BASE HEATER
STEAM
REFLUX PUMP
FINISHED GASOLINE TO STORAGE
THIS EQUIPMENT LOCATED AT RECOVERY PLANT



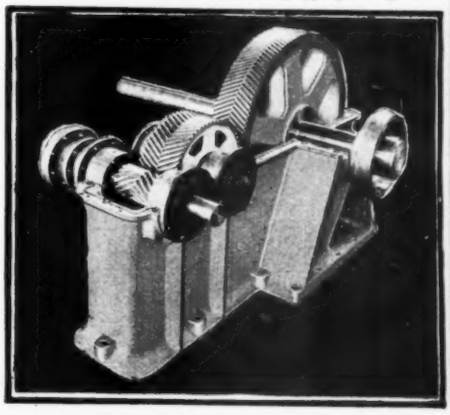


An East Texas installation



Crank "Thrown-out" while servicing well

Gear cover removed showing type gearing



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LUFKIN UNITS

square inch, depending upon the vapor pressure desired. The overhead from the column is used as fuel in the refinery. The capacity is 1.1 million cubic feet, extracting 90 per cent of the butane; or two million cubic feet when extracting 50 per cent of the butane.

A variety of control and recording instruments are used in this plant; Westcott proportional volume controls, Neilan pressure recording regulators, Foxboro Stabilog temperature controls and recorders, and Tycos pressure recorders. Neilan liquid level controllers are used on both units.

The reflux pumps are installed in the control house. Five horse power electric motors, manufactured for hazardous locations by the U. S. Electric and Mfg. Company, are used to run the Worthington centrifugal pumps.

The equipment in the new units is so designed and laid out that it is easily reached by the operator in case of an emergency, or so repairs and replacements can be made without any great inconvenience or loss of time. All of the columns are built with sufficient manheads to enable the mechanic to reach any of the trays or caps for cleaning, replacements, or inspection.

The design and arrangement of the pressure distillate stabilizer, recovery plant and final stabilizer have several important advantages for this type of refinery. In the first place treating costs are minimized, since it is necessary to acid treat only the stabilized pressure distillate. The load on the recovery plant is smaller since the light fractions from the pressure distillate by-pass it by going directly to the surge tank at the final stabilizer. The gasoline from the final stabilizer requires only a doctor wash to sweeten it.

The splendid results obtained during the test runs made on the new units demonstrated the high efficiency and ease of operation.

Winkler-Koch distillation unit, Producers & Refiners Corporation plant.

The West Tulsa refinery has a capacity of 6,000 barrels of crude per day. Only selected, sweet, Mid-Continent crude is processed. The crude is distilled in a modern Winkler-Koch unit, consisting essentially of a pipe still and a large fractionating tower. This unit is highly efficient and automatic in operation. The crude is fractionated into gasoline, naphtha, kerosene, and 38 A.P.I. gravity distillate. The reduced crude from this unit is cracked in the Dubbs units.

The Dubbs units produce coke and pressure distillate. The gasoline obtained from the pressure distillate has a high anti-knock rating, the octane number being about 70. The stabilized gasoline from these units is treated in a continuous treating plant with sulphuric acid and sweetened with sodium plumbite solution. The straight run gasoline from the crude unit is only doctor sweetened, as is the gasoline from the final stabilizer.

Some of the construction features of the Winkler-Koch installation are the extensive use of Merco Nordstrom valves throughout, a vapor-proof room housing the electric motors for the reflux pumps, and Braun heat exchangers. Brown temperature recording instruments are used on the unit. Worthington pumps are used for feed and reflux.

The new equipment installed at the plant enables the refiners to produce motor fuels that will meet the most rigid specifications or a balanced gasoline that will perform most satisfactorily in the modern high compression automotive engine. The cracking units produce the high knock rating, and the stabilizing units control the vapor pressure. The plant is also licensed to blend Ethyl gasoline, which is one of the principal products produced.

New Laboratory

The new laboratory building is a modern fireproof structure built of brick and concrete. The lighting, heating and ventilation are such that ideal working conditions can be maintained.

The building is divided into a number of separate rooms. The laboratory office and the technical library are in the front of the building to the right and left of the hallway. A chemist working on a problem can find ready reference on the subject. A very complete library on petroleum chemistry and technology will be maintained, including files of the leading periodicals.

The room directly behind the office is well equipped for analytical work. The back room is used for running knock rating on motor fuels. A standard Ethyl knock testing apparatus is installed. A special hood is used in which to measure the Ethyl fluid. Octane rating is determined on all of the gasoline produced at the plant.

A well equipped first aid room and a wash room is located behind the library. The wash room is equipped with showers for the chemists and testers. The first aid work for the refinery is taken care of in the laboratory. A side entrance to the building makes the room easily accessible from the plant.

The back room is used for a testing laboratory. Distillation, gravity, color tests, etc., are run here. The building also contains a room for retained samples and a stock room.

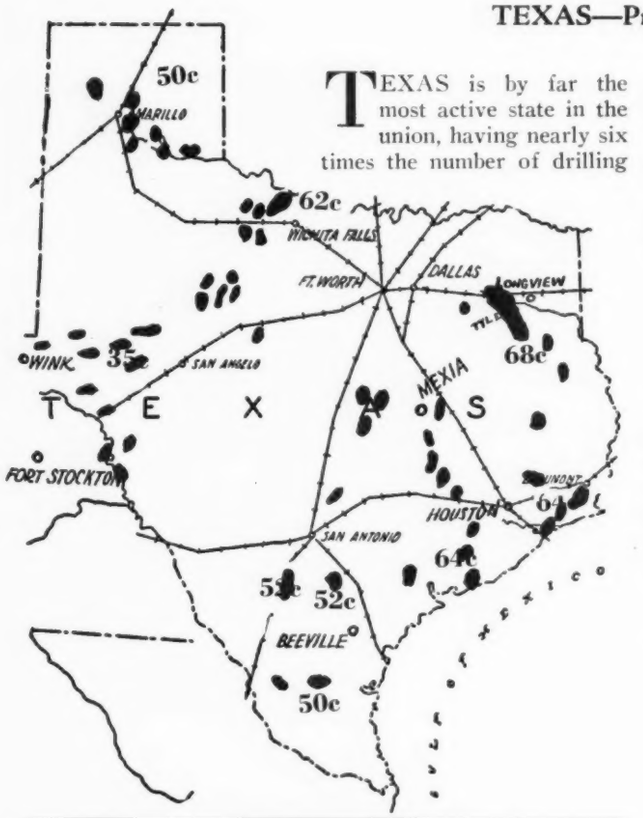
The laboratory is under the direction of Peter Vilkas, chief chemist of the refinery. L. P. O'Neil is his assistant.

No oil well can produce beyond the efficiency of its slotted pipe

KOBE HEAT TREATED SCREEN CASING

Latest Activities *in the* Oil Fields*

TEXAS—Production, 1930—290,720,000 Barrels



TEXAS is by far the most active state in the union, having nearly six times the number of drilling wells as any other state. The greatest portion of Texas' activity is in the East Texas field, where the huge total of 644 wells are actively drilling.

Texas had 825 drilling tests and 299 rigs, for a total number of 1,124 operations on October 1st. During the past month there were 722 permits for drilling and 534 completions. East Texas accounts for about three-fourths of these figures.

Following is a review of the active areas:

	POOLS			
	East Texas	Pan-handle	Van	Refugio
Number of Permits	541	1	1	0
September Completions	366	5	1	3
Number of Rigs	130	11	0	0
Number Drilling Wells	644	10	20	5
Gravity of Oil	40	36	36	26
Depth of Production	3600	2900	2600	6500
Type of Tools Used	Rotary	Rotary	Rotary	Rotary
Number of Casing Strings	2	2	2	3

CALIFORNIA
Production, 1930—228,612,000 Barrels

California had a total of 35 completions during September. The same number of new locations were made during that period. The state's activity is made up of 18 rigs and 172 drilling wells.

The California oil industry, as a whole, continues to mark time until things clear up, for which there are apparently no immediate prospects.

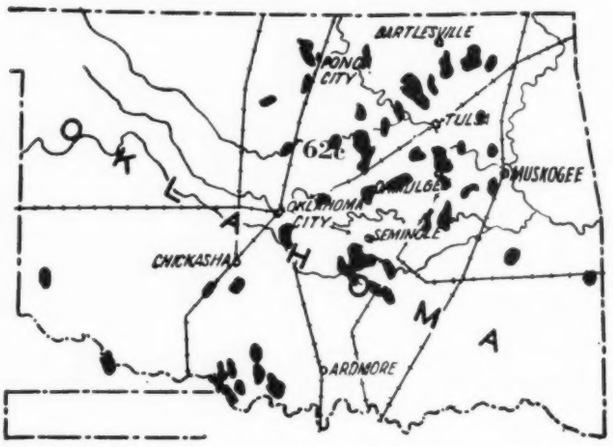
Following is a survey of activities:

	POOLS			
	Playa Del Rey	Long Beach	Kettleman Hills	Ventura
Number of Permits	2	1	1	0
September Completions	0	8	5	0
Number of Rigs	1	1	1	1
Number Drilling Wells	4	6	5	10
Gravity of Oil	23	26	60	36
Depth of Production	6000	7000	8300	7800
Type of Tools Used	Rotary	Rotary	Rotary	Rotary

* All statistics as of October 1st.

● Denotes oil and gas fields.

OKLAHOMA
Production, 1930—214,425,000 Barrels



Oklahoma oil field operations are featured by being the lowest in many, many years. The lack of drilling operations, however, is looked upon as a fine indication of future better conditions in the industry.

A tabulated summary of the state's activity and that in the Oklahoma City pool follows:

	Entire State	Oklahoma City
Number of Permits	62	4
September Completions	57	7
Number of Rigs	44	13
Number Drilling Wells	69	17
Gravity of Oil	36 (average)	39
Depth of Production	Varies	6400
Type of Tool Used	Cab.-Rot.	Rotary
Number of Casing Strings	Varies	3

Figures on maps indicate average prices of crude oil per bbl.

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for

Every Oil Field Purpose

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Our long experience in the Oil Fields has made it possible for us to know the needs of this Industry, and our research work and our manufacturing facilities have enabled us to develop a correct type of Leschen Wire Line for every condition.

Moreover, all Leschen Steel Wire Lines are made of acid open-hearth steel wire, and every wire is first rigidly tested by us to make sure that it comes up to our established standards and requirements.

You experienced Oil Men know that your operating costs depend a whole lot on the kind of service you get from your wire lines, so why not play safe by using Leschen Lines—they have proved in actual Oil Country work that they are dependable and economical.

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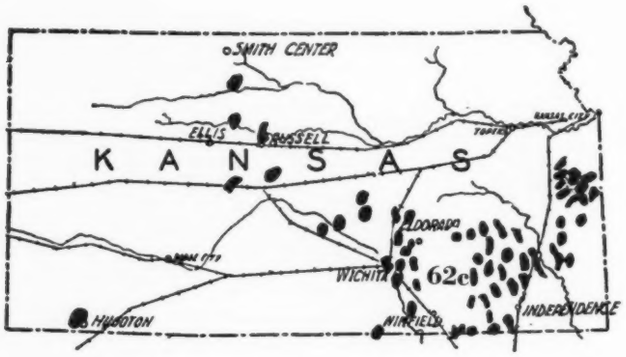
KANSAS—Production, 1930—41,745,000 Barrels



Kansas activity continues to remain practically the same. Last month there were 61 drilling wells and 31 rigs, while 36 permits and 40 completions were made. Both rotary and cable tools are used in this state, however, the latter type predominates.

Following is a summary of the active fields:

POOLS

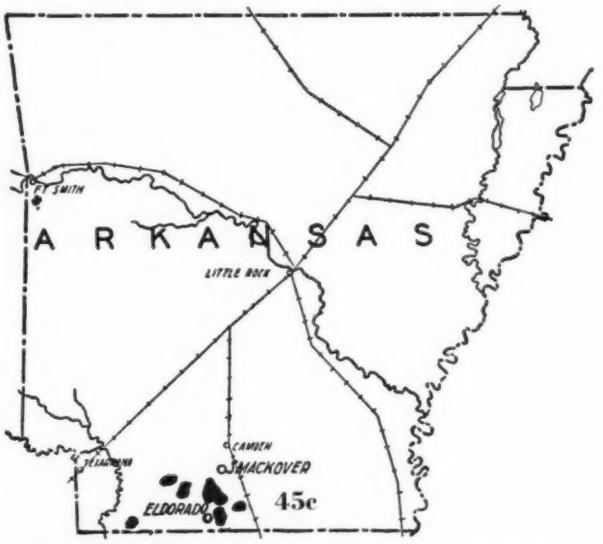
	Sedgwick County	McPherson County	Hugoton Field
Number of Permits	1	9	2
September Completions	2	18	2
Number of Rigs	0	14	0
Number Drilling Wells	4	24	2
Gravity of Oil	39	37	Gas
Depth of Production	2900-3500	2900-3400	2700
Number of Casing Strings	2	2	2

ARKANSAS

Production, 1930—19,680,000 Barrels

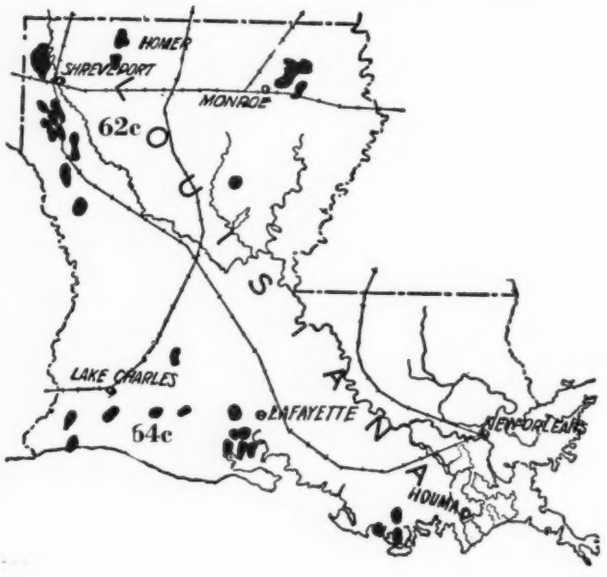
Two new locations and three completions were made in Arkansas during the past month. The state had six rigs and 22 drilling wells.

Rotary type tools are used in the state, formations penetrated frequently carry heavy gas pressures and are usually of a soft and cavey nature.



LOUISIANA

Production, 1930—23,150,000 Barrels



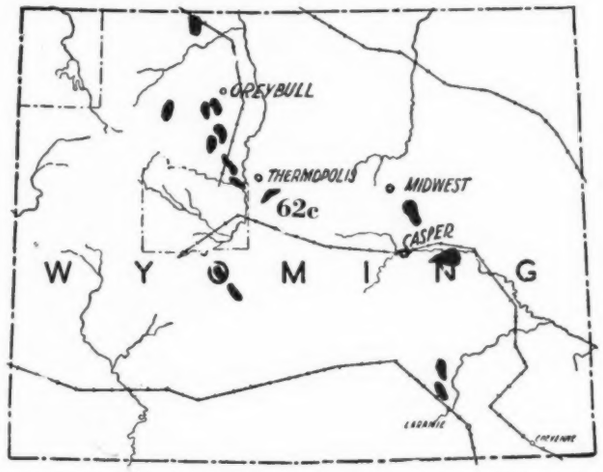
Louisiana oil field activity consisted of 31 new permits, 18 completions, 19 rigs and 71 drilling tests during September. Rotary tools are operated in both the Gulf Coast and North Louisiana regions. Formations are generally soft and cavey and yield high gas pressures.

Mississippi, adjoining to the east, had two tests completed, and six rigs and 14 drilling wells were carried on its activity report.

WYOMING

Production, 1930—11,177,000 Barrels

Ten completions, nine rigs and 81 drilling wells comprised Wyoming's oil field operations last month. Most operators employ cable tools for drilling in the state.



● Denotes oil and gas fields.

Figures on maps indicate average prices of crude oil per bbl.

NEW YORK

Production, 1930—3,825,000 Barrels

PENNSYLVANIA

Production, 1930—12,810,000 Barrels

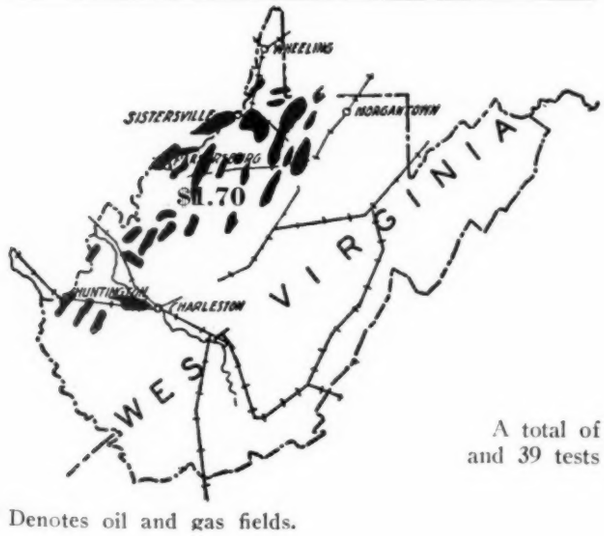
A total of 72 tests were finished in New York and Pennsylvania during September. The two states had 21 rigs and 87 drilling wells at the end of the month. The Tioga-Wayne region continues to lead with 12 rigs and 53 drilling wells.

ILLINOIS

Production, 1930—5,695,000 Barrels

There were two completions made in the state of Illinois during the past month. Other activity consisted of two rigs and 18 drilling wells.

Operating concerns in the area used standard tools for drilling to the shallow producing depths, that generally offer no difficult drilling problems.



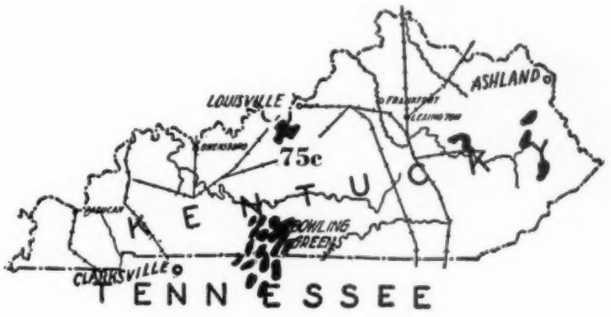
● Denotes oil and gas fields.

KENTUCKY

Production, 1930—7,300,000 Barrels

Kentucky field reports showed 16 completions, eight rigs and 88 drilling tests for September. In Tennessee there were no completions and no new rigs and only 13 drilling tests.

Drilling in both the states is carried on with standard type tools.



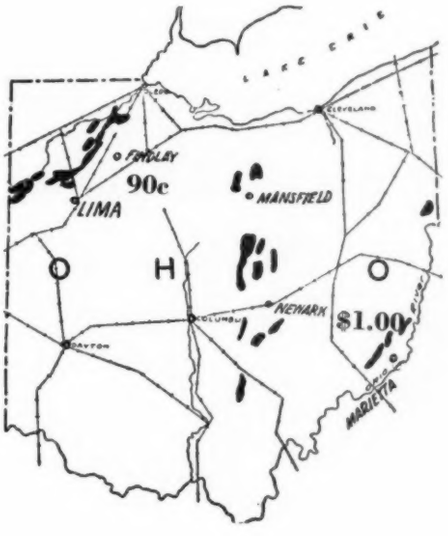
TENNESSEE

Production, 1930—20,000 Barrels

OHIO

Production, 1930—6,525,000 Barrels

Ohio had 88 completions, 40 rigs and 130 wells drilling during the month of September. Activity is mostly in the central Ohio district, where 27 rigs and 98 drilling tests are located. These wells are being drilled with cable tools.

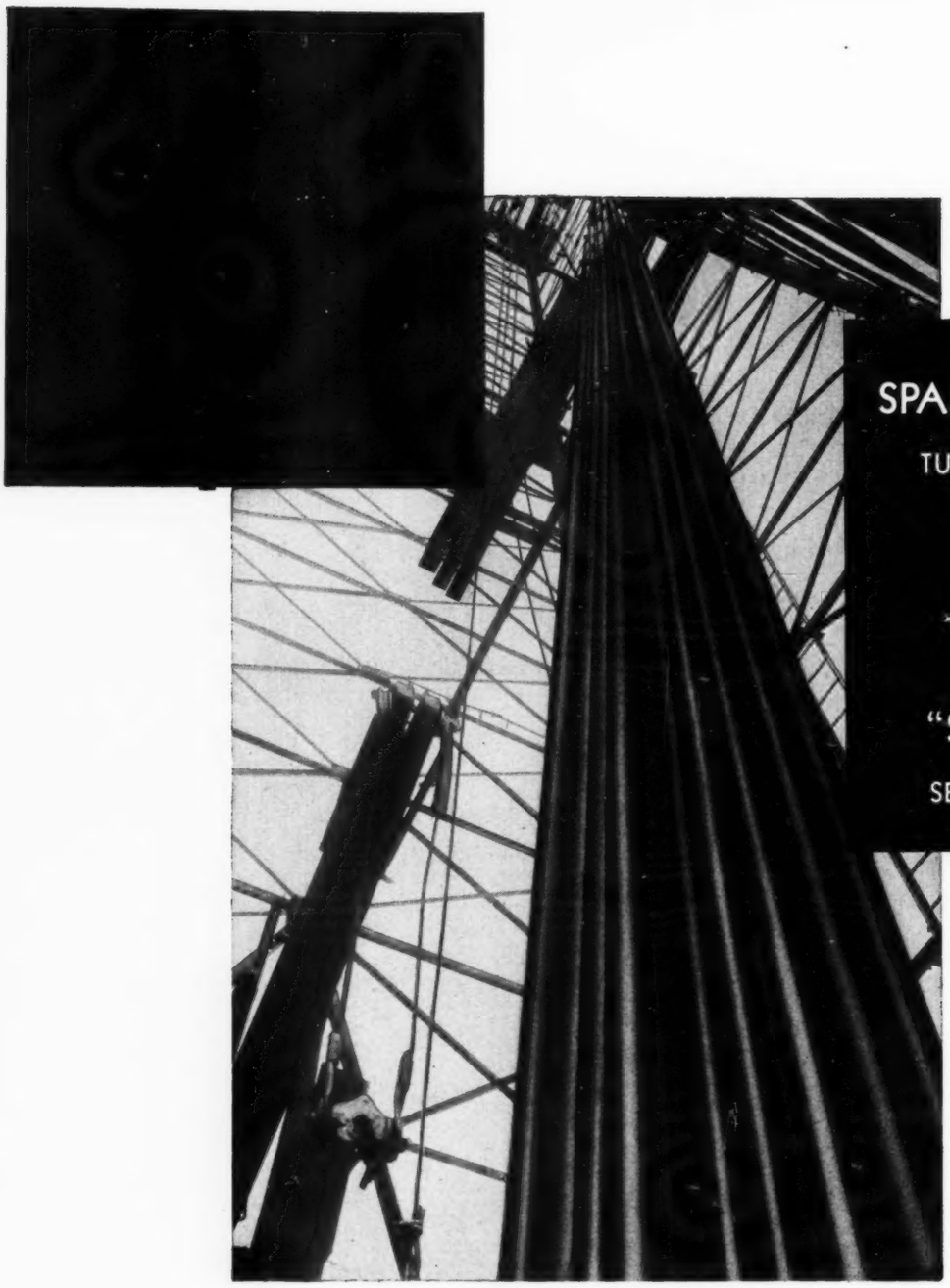


WEST VIRGINIA

Production, 1930—5,100,000 Barrels

A total of 27 tests were finished in West Virginia last month. Ten rigs and 39 tests are drilling in the state, all operating with cable tools.

Figures on maps indicate average prices of crude oil per bbl.



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NEW MEXICO

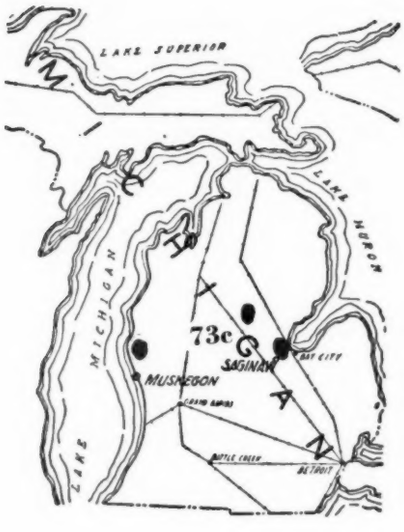
Production, 1930—10,235,000 Barrels

Oil field developments in New Mexico continue to follow routine lines and to show a decline in activity. The greatest activity is still centered around the southeastern portion of the state in the neighborhood of Hobbs.

Last month only five wells were completed in the state. Other activity included three rigs and 44 drilling tests. The Hobbs pool, greatest pool found in the state, has been developed with rotary type tools due to upper gas pressures that need to be controlled while drilling. Cable tools are used in other parts of the state.

MICHIGAN

Production, 1930—3,525,000 Barrels

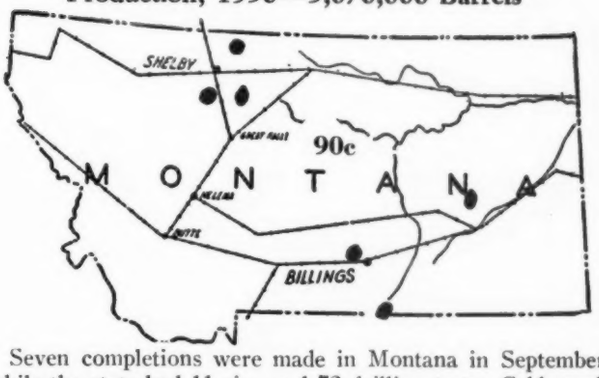


Activity in Michigan continues to be quite large, last month there were 98 drilling wells and 59 rigs. September had 12 completions in the state.

Practically all the wells in this state are drilled with cable tools and rigs. In a few instances rotary tools have been used.

MONTANA

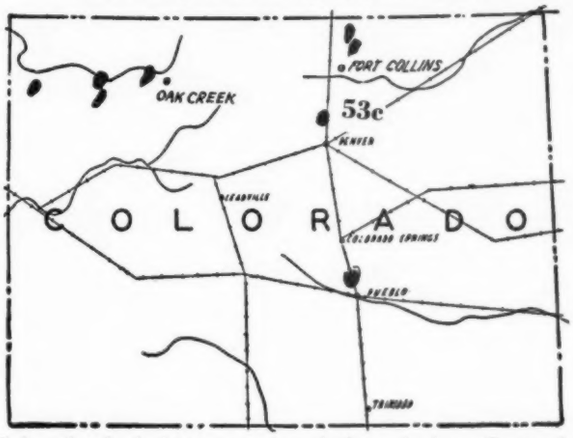
Production, 1930—3,070,000 Barrels



Seven completions were made in Montana in September, while the state had 11 rigs and 72 drilling tests. Cable tools are the most common means of drilling.

COLORADO

Production, 1930—1,644,000 Barrels



Colorado had but one completion during September. There are seven rigs and 78 drilling wells in the state. The new Platte Valley field received the one completion and is the most interesting spot in the state. Rotary and cable tools are used in the state.

INDIANA

Production, 1930—1,000,000 Barrels

A total of 14 tests were completed during September and August, while its oil field activity reports were made up of five rigs and 48 drilling wells.

The shallow producing depths are easily and quickly reached, contractors using standard tools for all their operations.

● Denotes oil and gas fields.

Figures on maps indicate average prices of crude oil per bbl.

Progress of Major Pipe Line Work

By J. H. DAMERON

SEVERAL major pipe line projects throughout the country were completed during the past thirty days.

Fairly reliable rumors sift through the trade concerning contemplated major extensions and the building of some new lines. The new work reports hinge mainly around the gasoline lines and a rumor persists that another gasoline line is to be built from one of the Mid-Continent centers to northern and northeastern markets.

GREAT LAKES PIPE LINE CO.

Great Lakes Pipe Line Co., with its long gasoline artery stretching from Oklahoma to the Great Lakes region, finished construction of its entire system with the completion of a 115-mile 4-inch lateral terminating at Omaha, Nebr. This combination 6 and 8-inch welded carrier embraces approximately 1,440 miles of line and its Diesel-powered reciprocating pump stations are running to capacity to transport the shipments of refined products.

SOUTHERN FUEL CO.

On the Pacific Coast the Southern Fuel Co. has completed construction work on its combination acetylene and electric welded 26-inch gas line running from Kettleman Hills to Long Beach and Los Angeles. The new system, augmenting the existing lines supplying the Los Angeles area and supplying fuel to a huge generating plant at Long Beach, called for the construction of 185 miles of line. Part of the line's route traversed mountainous country where the most difficult construction problems were encountered. Field pressure will be utilized to operate the line for the present.

Indicates completed portion of line.
Indicates proposed route of line.

LINDEWELDING

A Lindewelded 26-in. section of a 210-mile gas line in California.

. . .

Inset shows the Lindewelder, a special appliance which further increases the speed of Lindewelding.

a speedier and cheaper method of OXY-ACETYLENE WELDING

ON a Lindewelded oil line in Texas, it was necessary to run the oil through before the last 15 miles were in the ditch. The line was lowered while the oil pressure ranged from 300 to 600 pounds. Not a joint failed. Lindewelds are strong.

But that is not all:

Lindewelding increases welding speed 30 to 60 per cent. and reduces welding material consumption 35 to 40 per cent.

Lindewelding can be done with ordinary blowpipes or with special apparatus which makes welding almost automatic and further increases its speed. Experienced welders quickly adapt themselves to it, and beginners learn it more readily than other methods.

Procedure Controls for this new method of oxy-acetylene welding are available to all Linde customers through Linde Process Service. Any Linde District Office will be glad to give you complete information.

See this Motion Picture on Lindewelding

Lindewelding technique differs from oxwelding technique in that it employs a special rod, a special flame adjustment, and the "back-hand" method of blowpipe manipulation. The actual steps in making a Lindewelded joint are shown in our motion picture, "The Lindeweld Process for Pipe Line Construction." This picture will be loaned without charge to pipe line officials and welding or engineering societies. It is furnished in 16 mm. and 35 mm. safety film and can be obtained by writing to any Linde District Office.

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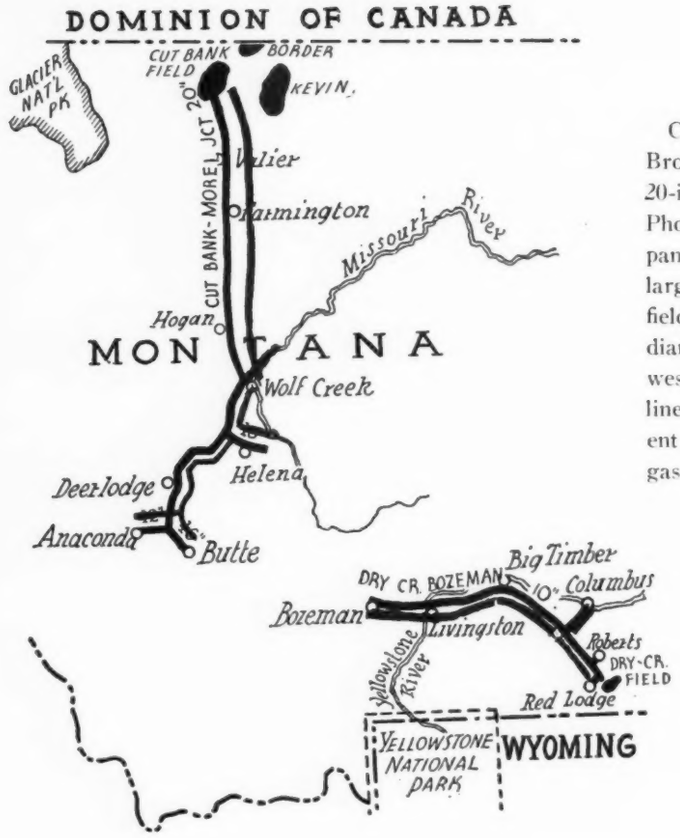


MONTANA POWER CO.

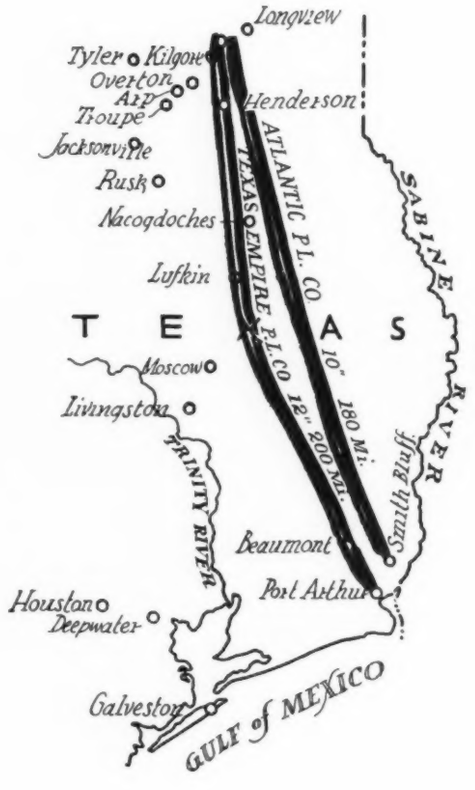
Cutting through the mountains in Montana, Winston Bros., Minneapolis, contractors, have completed the new 20-inch gas system in Montana for the Montana Power Co. Phoenix Utility Co. engineered the job for the power company. The work was divided in two projects, with the larger being the 20-inch line originating in the Cut Bank field and terminating at Butte and Anaconda with smaller diameter lines. The smaller was the 10-inch line running west from the Dry Creek field to Bozeman with a 10-inch line. Both systems are welded construction. For the present the ample well pressure will be used to transport the gas from the fields to delivery points.

ATLANTIC AND TEXAS EMPIRE LINES

In East Texas two transporting companies rushed their oil line projects to completion and are running East Texas crude through them to terminal facilities on the Texas Gulf Coast. The Atlantic Pipe Line Co. completed its 180 miles of 10-inch welded line from East Texas to harbor facilities at Smith Bluff.

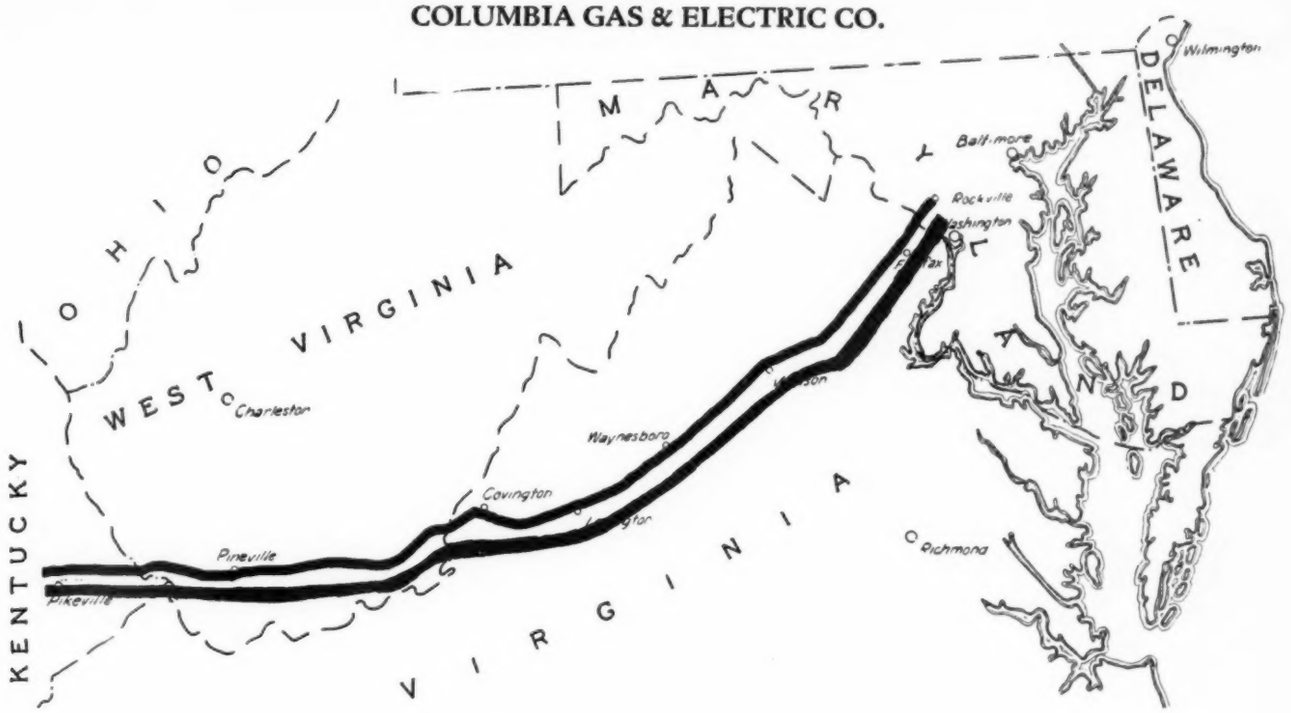
The Texas Empire Pipe Line Co. made a 30-day job of the building of its approximately 200 miles of welded 12-inch line from East Texas to terminal facilities at Port Arthur, Texas. Construction work for the line was split up in five 40-mile sections and awarded to four contractors who tied in their sections to the main line 30 days after receiving first pipe.

Both lines were started about the time martial law was declared in East Texas and which brought about a temporary shut-down of field operations. Both were completed shortly after the production ban was lifted.



Indicates completed portion of line.
Indicates proposed route of line.

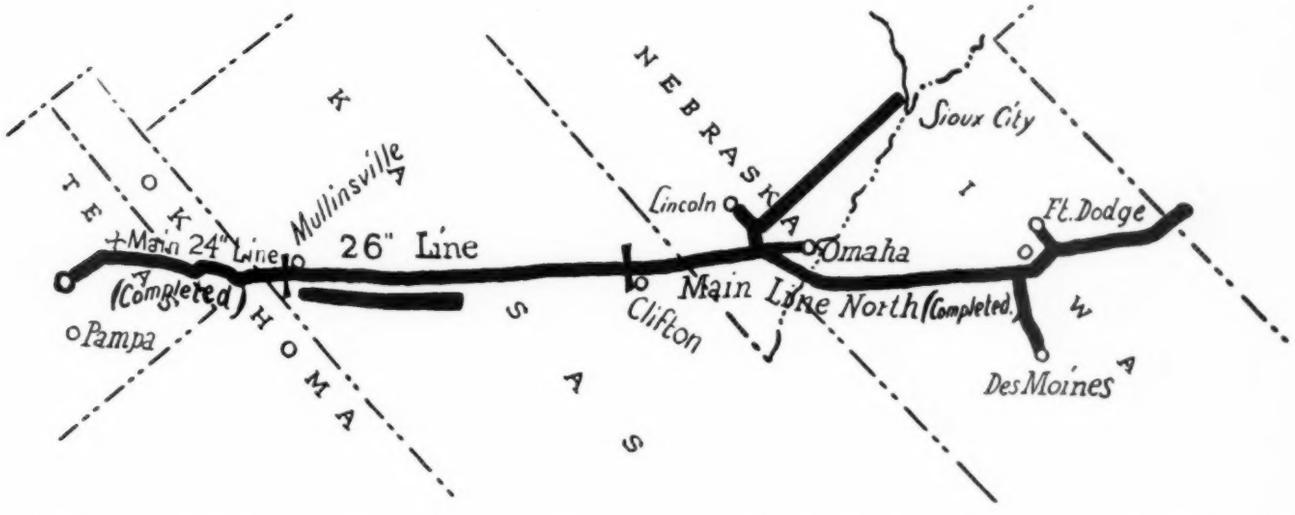
COLUMBIA GAS & ELECTRIC CO.



Over near the Atlantic seaboard the Columbia Gas & Electric Co. is winding up construction work on its 350-mile, 20-inch gas line originating in eastern Kentucky and tieing into the company's older system at Rockville, Md. The single compressor station at Eliza Forks has been completed and is ready for operation.

This will serve new connections along its right-of-way and help feed the main line system running along the southern border of Pennsylvania. It also supplies gas to the nation's capitol at Washington. Because of the broken character of the country traversed, many unusual construction problems were encountered.

MISSOURI VALLEY P. L. CO.



Construction work on the Missouri Valley Pipe Line Co.'s combination welded and coupled 26-inch line is showing steady progress. This 200 miles of new work will tie in the transmission company's existing 24-inch main line, which could not be completed in time for service last year. It is the first line of such large diameter pipe to be laid in this section of the country. Smith Brothers, Dallas (Texas) contractors, are laying the line.

Indicates completed portion of line.
Indicates proposed route of line.

The Month's Activities *in* Refining*

By F. R. STALEY

MUCH of the construction work is now finished at the Sinclair Refinery on the Houston ship channel. Two of the De Florez units, and the Badger rerun still started operation during September. Victor H. Smith, president of the Coastal Petroleum Corporation, has announced that his company has contracted with the J. P. Devine Mfg. Co. for the erection of a 5,000-bbl. Pratt vapor phase cracking unit to be erected in their new refinery on Blakely Island opposite Mobile, Ala.

The Marathon Oil Company is planning to install some new equipment in its Bristow refinery.

The Arrow Refining Company is planning to produce special naphthas at its refinery at Overton.

The refinery of the Hutchinson Refining Company at Hutchinson, Kansas, has been reconditioned and is now operating on Rice County crude.

Several new refineries are nearing completion in the East Texas field. They include two small topping plants, and the 10,000-barrel plant of the Petroleum Refractionating Corp.

The new plant of the Mountain States Refining Company at Orchard, Colorado, will start operations about October 15th. E. E. Calkins and A. E. Shogren are president and vice-president, respectively, of the company.

The Barnsdall Refining Company has been successfully manufacturing various alcohols from petroleum at Barnsdall, Oklahoma, and is considering the erection of a large commercial plant, the location of which has not been announced.

The Continental Oil Company furnished the program for the Oklahoma Section of the American Chemical Society at Ponca City, September 26th. Several interesting papers on refining technology were presented by members of the refining staff, and after lunch in the Conoco Club, inspection tours were conducted through the refinery. Dr. Zurcher of the Continental arranged the program.

A Road Oil Congress was held in Tulsa, October 8 and 9. Many highway officials and petroleum technologists attended the meetings. Four papers dealing with road oils and their application were presented.

The U. S. Bureau of Mines has recently released report of Investigations 3130 on the "Properties of Crude Oils From the East Texas Field."

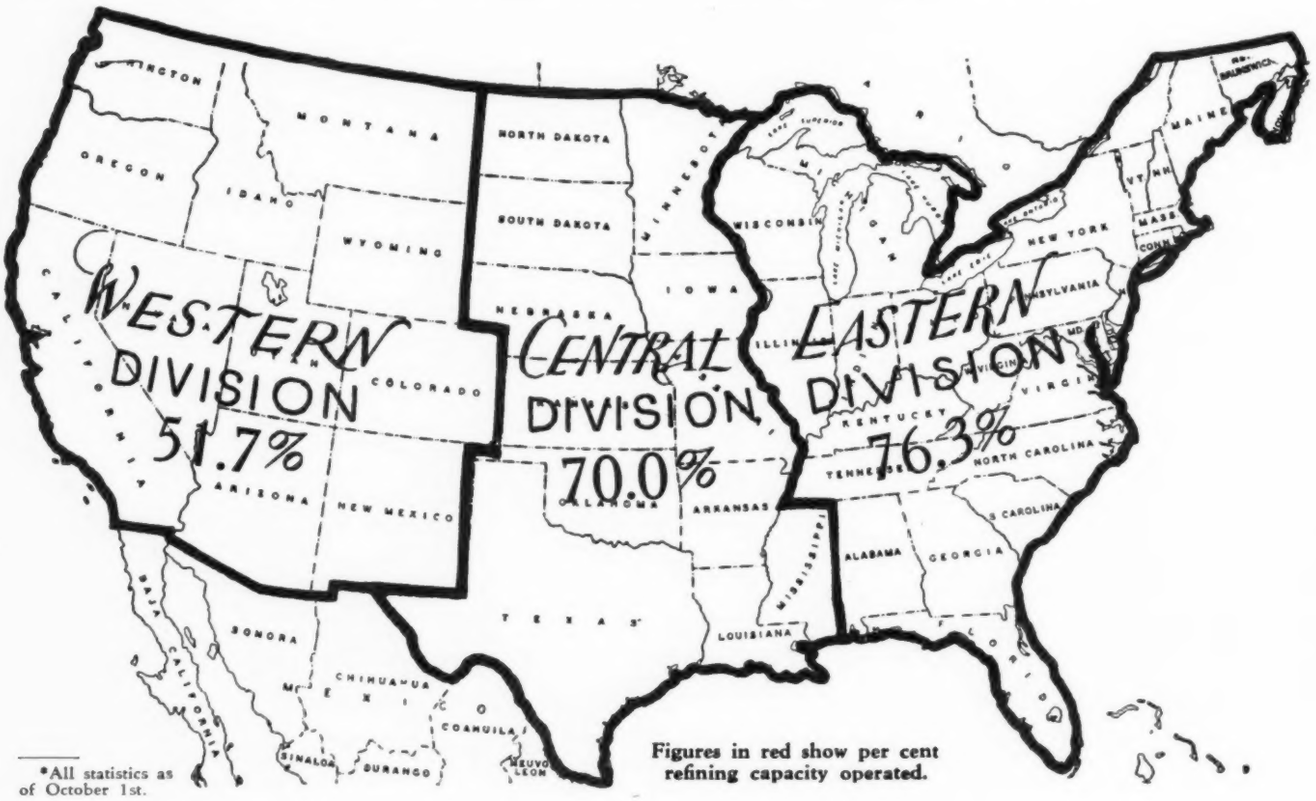
According to a canvass just completed by the U. S. Bureau of Mines both the production and consumption of acid sludge at petroleum refineries increased in 1930. It is estimated that four per cent of the total heat utilized at oil refineries is now supplied by burning acid sludge. The indicated production of acid sludge in 1930 totaled 8,568,000 barrels.

Proceedings of the Tenth Annual Convention of the Natural Gasoline Association of America are now ready for distribution and can be secured from Ray E. Miller, secretary, Wright Bldg., Tulsa, Oklahoma.

The Southwestern Engineering Company is building a new absorption plant for the Sunray Oil Company in Moore County, Texas Panhandle.

The Continental Oil Company and the Signal Oil Company have completed a new gasoline plant in the Big Lake field, Texas.

Several companies, including the Barnsdall Oil Company and Sinclair Oil and Gas Company are planning the erection of natural gasoline plants in East Texas.



Figures in red show per cent refining capacity operated.

*All statistics as of October 1st.

PATENT NOTICE

radiant heat furnaces

The Alcorn Combustion Company originally advocated and developed the use of radiant heat as the safest and most effective means of heating oil in tube stills and cracking coils.

The method of heating oil by and the apparatus for separately applying radiant and convection heat to different parts of the heat absorbing structure was developed by the Alcorn Combustion Company.

Notice is hereby given that any furnaces used in connection with distillation units, cracking coils, or reforming units in which certain tubes receive heat substantially solely by radiant heat, and other tubes are heated by convection heat, is an infringement of U. S. Letters Patent No. 1,591,431 issued July 6, 1926. owned by the Alcorn Combustion Company.

The Alcorn Combustion Company will take such legal action as may be necessary to fully enforce their patent rights.

THE

ALCORN COMBUSTION COMPANY

Bellevue Court Bldg. **Philadelphia, Pa.**

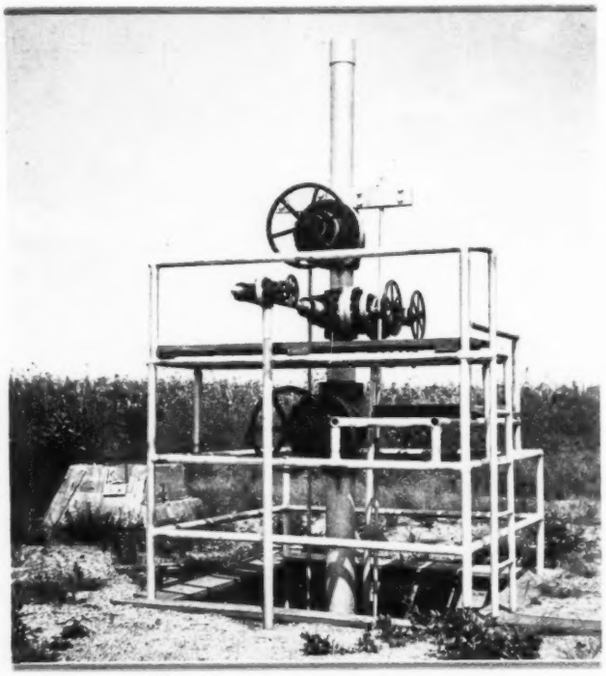
TULSA OFFICE
Court Arcade Bldg.

LOS ANGELES - SAN FRANCISCO
California Representative
Pacific Abrasive Supply Co.

HOUSTON OFFICE
Petroleum Bldg.

Important Phases of Gas Well Hook-Ups

MID-CONTINENT gas production engineers have, with the increased demand for natural gas as a result of the completion of several major gas line projects, devoted considerable time to studying the best producing methods for gas wells, with the result that longer lives are now expected from them. Proper installation of the best equipment is an essential requirement in operating producing gas wells. Many different producing conditions found in gas wells makes it important to first ascertain these characteristics of each and then to install the right designed flowing connections if economical operation is to be secured. After drilling a well into a gas sand the first requirement, following a good setting of the casing, is to clean it out. Frequently, heavy pressures will blow the cuttings and cavings out of the hole, but in the case of smaller wells the flow of gas may be retarded by cavings. Frequently, especially when drilling with rotary tools, the mud becomes hard and will seal off part of the producing sand, with the result that the well's flow is materially retarded.



Hook-up on Winona Oil Company's No. 1 Streeter in the Holdenville, Okla., district.

The Cities Service Gas Company for some time has been cleaning out its gas wells by running slotted joints of tubing on the lower end of the string. Water is pumped into the tubing and used to wash the cuttings and cavings out. The method is quite simple to perform, requiring only enough joints of tubing to be slotted to cover the producing sand thickness. Water is pumped down the tubing under sufficient pressure to carry out the loose formation between the tubing and flow string of casing. As much as 60 feet of cavings have been cleaned out in this manner from one well. This method may also be used on older wells where the hole has caved. In some instances the company leaves the string in the hole after cleaning out so that it may be used for future cleaning-out jobs and as a flow string during the well's period of production.

The increased gas flow and reduction in trouble due to less obstruction to the natural gas flow has demonstrated the efficiency and economy of the method. It has been found that when this operation is performed at the time of completion that the well ordinarily requires less attention for a longer period of time than is otherwise generally the case. The greater and longer sustained flow repays the slight expense of the operation. The possibility of well connections being cut due to loose sand being carried out of the hole under great pressure is also reduced.

Since most gas wells produce various amounts of fluids in the form of either fresh water, salt water, oil or gasoline, the problem of handling this fluid is a paramount one to gas operators. The principal factors in equipping wells so their fluid production may easily be handled is the amount of fluid produced and what kind of fluid is present.

When a gas well is first drilled in, the value of a syphon line installation is worthy of consideration. If a good sized well is found it will prove exceptionally economical. Syphon or bleeder lines consist of five to ten feet of slotted or perforated tubing, plugged at the bottom and penetrating up through the Christmas tree. It is equipped with a blow-off valve on the top so that the water may be blown into the air. The properly installed bleeder line, however, is connected into the pipe line in a manner that will permit it to be operated from a side gate without disturbing the gas between the tubing and casing. This way will allow the taking of a little fluid out of the well at a time, which may be caught in the gas line drips instead of in slugs of several barrels each, giving the practice many features, such as: Reduced gas wastage, since less pressure will be required to lift the fluid out of the hole, and this gas is carried into the pipe line; smaller danger of gas lines freezing, as the drips will not fill so quickly and there is less danger of the fluid passing by them; a saving in rock pressure, due to the fact that the pressure at the sand is never released; and there is also less likelihood of the hole caving.

The amount of fluid produced by gas wells may be materially reduced by applying back pressure with flow beans. This method is frequently adhered to in cases of high-pressure wells and has been quite successful in retarding the fluid flow. Even with the application of back pressure and the installation of one or more drips, an excessive amount of fluid is sometimes present in gas wells and it is then desirable to install a separator of suitable size and design, of which there are several on the market.

Separators are ordinarily installed on the downstream side of the flow bean, the gas passing from the downstream side of the flow bean to the separator and returning from the separator on the downstream side of a blinded meter flange. Very high pressure wells often require a series of separators, in which case the flow beans, or whatever means of pressure control devices are used, are located directly on the Christmas tree of the well.

In only a few cases in the Mid-Continent is water pumped from gas wells by sucker rods and jacks. In the older areas, where such operations might be found, the water is

usually bailed out. This is not an expensive operation when wells are not too deep. Some companies have specially-equipped trucks and crews that continually make the rounds doing nothing but bailing out wells.

The old practice of shutting in a well and permitting it to gather a head and then blowing it into the air to dispel the water is rapidly being discarded as a means of clearing the hole of fluid because of its gas wastage.

Although the Mid-Continent area has not experienced severe trouble with salt water, it is found in troublesome quantities in some areas. This briny fluid sometimes crystallizes on the face of the sand and is carried into the tubing, which must be cleaned out from time to time as the salt bridges its interior. A common method of cleaning out is to run a few barrels of fresh water into the hole and permit it to stand several hours. The salt bridge will dissolve during this time and may then be bailed out.

Rarely cases will be found where salt bridges are so serious that it is necessary to remove the deposits with a small string of cleaning-out tools. Whenever readings indicate a well is salting up, serious jobs can be averted by quick cleaning out. It has become a general practice to install one or more drips to catch the produced fluid after it leaves the well and before it reaches the main line meter. Some companies have a policy of installing one drip when a well does not show a large amount of water at the time of completion, and later, when the fluid flow has increased, additional drips are installed.

The type of drip and its size depend upon the quantity of gas and fluid; thus they are built to care for individual wells. The usual type in the Mid-Continent consists of a pipe larger in diameter than the one from the well. The length of this pipe varies greatly, according to the amount of fluid produced. At either end of this pipe run is attached a pipe at an angle, which in turn is attached to another pipe running at an angle to the latter. The gas is separated from the fluid by the result of expansion and slowing up of the flow.

All field meter runs should be equipped with preheaters to prevent freezing. When gas is reduced, by means of regulators, from a very high pressure to low pressure, the operation of the regulator is often difficult because of frosting or "freezing," which is the result of a fall in temperature in the gas as the pressure is lowered. Whether or not a regulator freezes in position and ceases to function as a regulator oftentimes depends upon the moisture content of the gas and its ability to form ice.

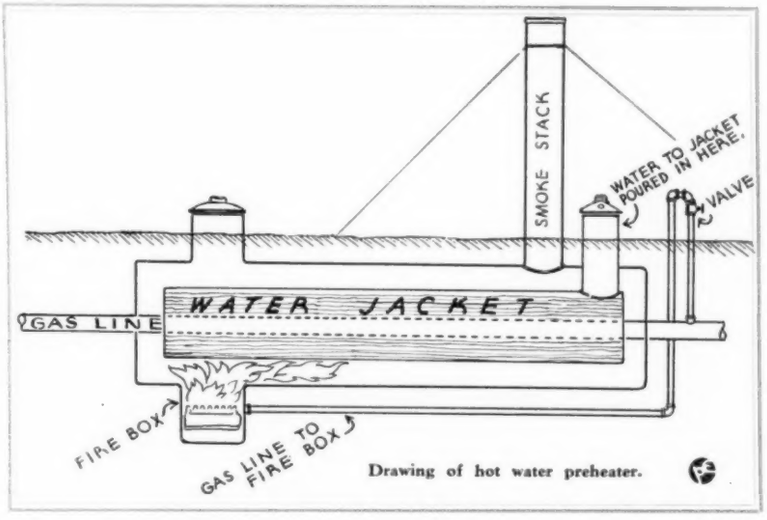
The gas temperature may be raised several degrees before it enters the regulator by simple types of heaters that surround the gas pipe, normally using a small regulator to control small flows of inlet gas to specially-designed burners ahead of the regulator. By raising the temperature of the gas several degrees it will have sufficient temperature to allow for the necessary drop in temperature and still have enough heat to keep the wet particles from freezing.

The Cities Service Gas Company preheater resembles a hot water tank lying parallel with the ground and has been quite successful in eliminating regulator freezing due to frosting of high-pressure regulators brought about by extreme pressure reduction.

The size of the preheater used by this company depends upon the gas line size. It consists of a water jacket surrounding the gas line and a larger diameter pipe surrounding the water jacket for a heating chamber and a fire box. On gathering lines, which are usually two-inch diameter pipes, the water jacket is made of eight-inch pipe and the heating chamber of 12-inch pipe.

An upright pipe connection from the water jacket to above the ground level affords the means of keeping water in the jacket. This jacket is flanged and welded to the gas line to prevent leakage.

At one end of the heating chamber is the fire box, which has a gas burner and two air lines. Gas to the fire box is supplied by a small tap in the gas line and is controlled by a valve or regulator on top of the ground. This tap is on the outlet end of the heater and, since the gas has already been heated when it reaches the tap, there is no danger of it freezing.



Drawing of hot water preheater.

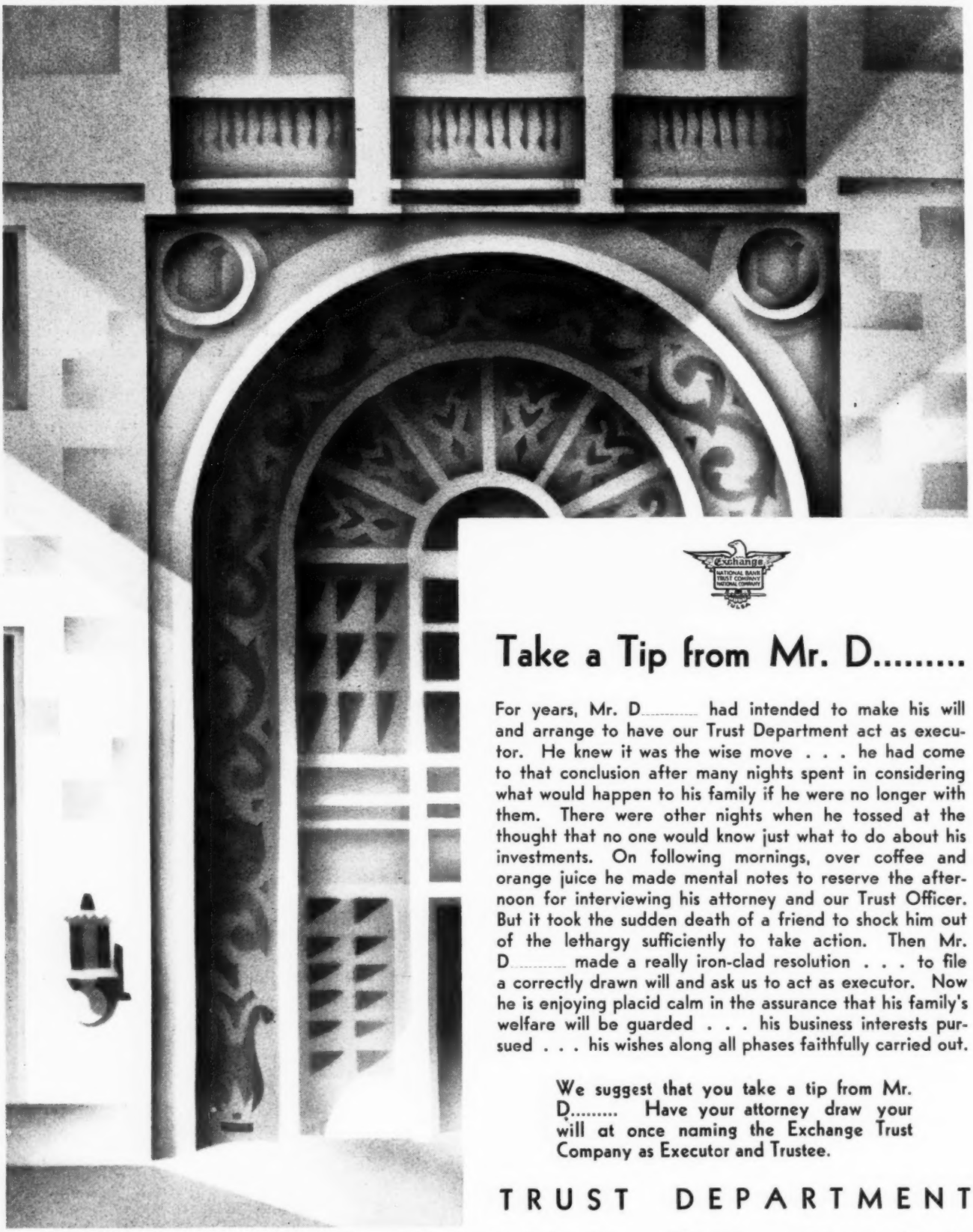
The heating jacket has a tall smokestack near one end. This supplies the draft and is also the outlet for gas fumes. The heating chamber jacket, like the water pipe, is flanged and welded to the gas to make it leak proof.

Freezing of regulators makes possible dangerous and harmful accidents as a wave of high pressure gas is sent into the meter setting and if this should reach domestic consumers extreme dangers would be offered. High pressure wells need to be better equipped at the Christmas tree than low pressure ones because safety must be taken into consideration along with proper producing conditions. Some companies do not like to install a master gate when a bleeder line is in the well; however, it provides a means of closing the hole when the last joint of tubing has been pulled above it and yet not entirely out of the other gates. Whenever it is desired to pull tubing for some operating trouble this proves an additional safety factor and eliminates gas wastage.

There is an increasing use of cross-trees on high pressure wells. The additional opening permits the withdrawal of gas for lease operations or other purposes whenever it is needed. The ideal well hook-up for the Mid-Continent has a 6⅝-inch gas head with slips for holding part of the tubing weight. Many gas operators swedge down from the side gate, so that the bleeder connection is inside the swedge, with sufficient two-inch to safely carry the rock pressure of the well. This two-inch should be of sufficient length to be suitable for installing a gas line heater.

An ideally equipped well has a recording gauge to keep the record of working pressure and its rock pressure when not delivering. Sometimes this is prohibitive because of the expense, but such records should be secured whenever possible as they will indicate the current condition of the well.

COMPLETE BANKING SERVICE



Take a Tip from Mr. D.....

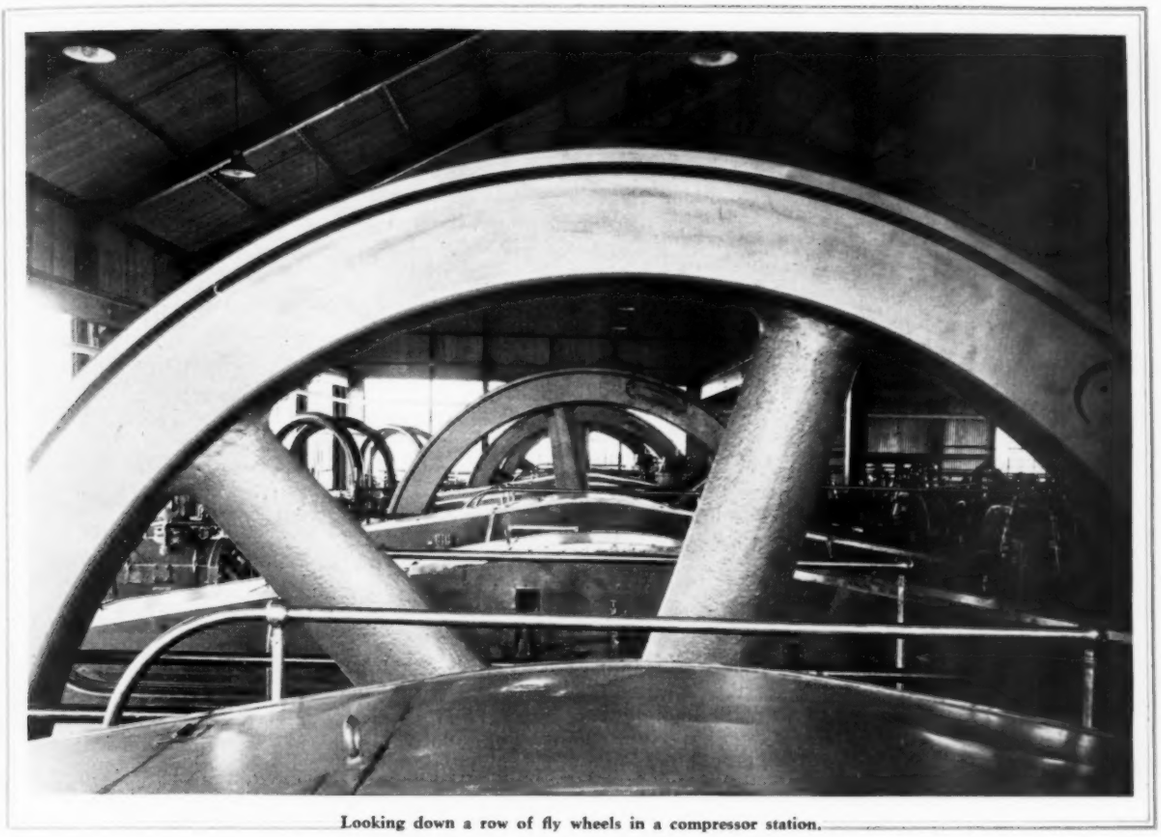
For years, Mr. D..... had intended to make his will and arrange to have our Trust Department act as executor. He knew it was the wise move . . . he had come to that conclusion after many nights spent in considering what would happen to his family if he were no longer with them. There were other nights when he tossed at the thought that no one would know just what to do about his investments. On following mornings, over coffee and orange juice he made mental notes to reserve the afternoon for interviewing his attorney and our Trust Officer. But it took the sudden death of a friend to shock him out of the lethargy sufficiently to take action. Then Mr. D..... made a really iron-clad resolution . . . to file a correctly drawn will and ask us to act as executor. Now he is enjoying placid calm in the assurance that his family's welfare will be guarded . . . his business interests pursued . . . his wishes along all phases faithfully carried out.

We suggest that you take a tip from Mr. D..... Have your attorney draw your will at once naming the Exchange Trust Company as Executor and Trustee.

TRUST DEPARTMENT

EXCHANGE BANKS OF TULSA

The Exchange National Bank ❖ Exchange Trust Company ❖ Exchange National Company



Looking down a row of fly wheels in a compressor station.

Recent Developments in Station Pumping Practices

ALONG with the wide expansion of the oil industry's pipe line system in the past three or four year's there has been a greater development in pumping station practices. Remote controlled automatic stations have been one of the most notable of the new and modern practices. Along with several other newer methods the pipe line engineer has a much wider range in buying pumping machinery for the temporary and permanent installations.

As a result of these developments operating as well as installation charges have been lowered at the field stations and on up the scale to the larger and more costly main line stations. Efficiency of machinery has been increased and where high salvage after a comparatively short period of service is wanted the portable equipment is answering that demand.

The remote controlled motorized stations have been developed rapidly within the last few years. During the experimental stage this type of station has been used in booster station work on main lines. Its development followed the general introduction of the centrifugal pump in main line and booster stations.

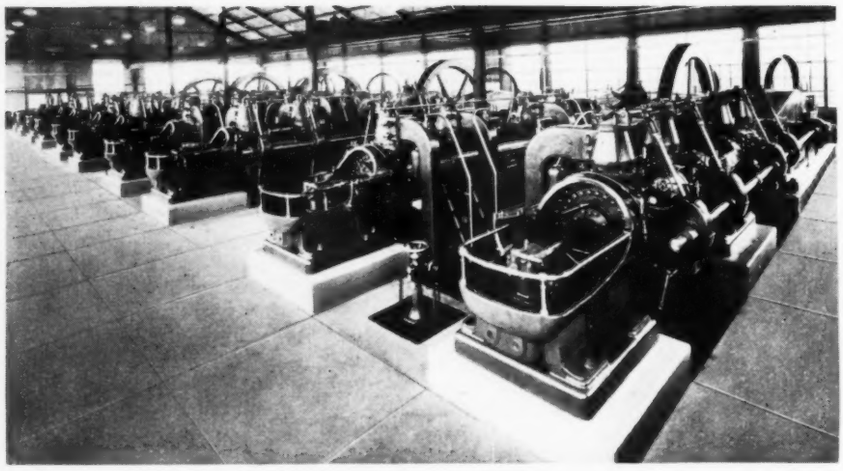
Motor-driven valves and the various types of protective devices to protect the station against excessive increases or drops in pressure, hot bearings, etc., have played no small part in the development of the stations operated through the pipe line's communication system. With them, an engineer at a control station may sit at his desk and through push buttons start as many units as desired in the remote controlled booster station. The operation of these units, opening and closing of necessary gate valves at that station is easily observed. Etched on a large metal plate facing him is a schematic layout of the station. Various colored lights burn as valves open and units start and other lights flash on when any trouble develops.

With the signaling devices it is difficult to start the station into trouble and as a further precaution of preventing too quick starting of succeeding units time relays are installed.

In this connection one of the most recent developments in remote control is in a booster station on an oil line in Kansas. No communication line existed along the main line so it was decided to operate the station on a pressure-volume differential.

The station behind the booster is equipped with motor-driven centrifugal pumps and the booster station equipment consisted of two motor-driven centrifugal pumps. To cut the booster in all that is necessary is to pinch the discharge gate on one of the pumps at the control station. When this is done, both the volume and pressure is lowered and when such a condition exists at the booster station at a predetermined figure for 60 seconds the first pump starts. Thirty seconds later the second unit starts. By observing the pressure gauge the operator at the control station may see when the booster goes on the line and then open the pinched gate valve and start another unit at his station.

Control of the booster is accomplished through mercury switches set for various pressures and a recording flow meter, both of which operate time relay switches. It is



Interior of gas line station with 1,000 h.p. units.

stopped by lowering the pressure and volume. Like other automatic stations it is protected against common sources of trouble by protective devices.

Such a station, of course, has only one operating setting or condition. If it is desired to change the starting and stopping pressures and volumes, this may be done by changing the setting on the flow meter and switches. If only pump is desired to be operated the line walker may readily close the necessary gate valves at the station and open necessary switches to prevent the second unit cutting in.

Any material change in deliveries is usually known about a day ahead of time and the layout for cutting out one unit is simple. Consequently the line walker may make the change during his daily trip and without being awed by a maze of electrical switches and valves.

Unlike the other remote control stations where an attendant is on duty to keep machinery clean and lubricated, this type of station will not have an attendant. As a booster plant its average operation will probably be several hours each day. When the line walker passes he will care for lubrication and check it on his return later in the day.

Another of the recent developments in station practice is the driving of centrifugal pumps with engines through increaser gears. On one of the gasoline lines built from the Mid-Continent to Mississippi Valley markets used gas engines as prime movers. These burned butane, which is slugged through the line and vaporized as needed for fuel.

The engines drive the high speed centrifugal pumps through a set of gear increasers which are located on the engine room side of the station. Another pipe line company operating a crude oil line is using Diesel engines to drive centrifugal pumps through gear increasers.

While the Diesel engine has been more or less out of consideration in the design of automatic pipe line stations for obvious reasons, designers are giving serious thought to their adaption to this phase of station operation. Experts on Diesel engine application have for some time considered various methods of automatic control for the relatively slow speed units.

A short while ago a light weight high speed engine was brought out and its application in a remote controlled Diesel station is being considered by a transporting company and engineers for pipe line station designers and contractors. Its use on such an installation is being studied both for the reciprocating type of pump and the centrifugal unit.

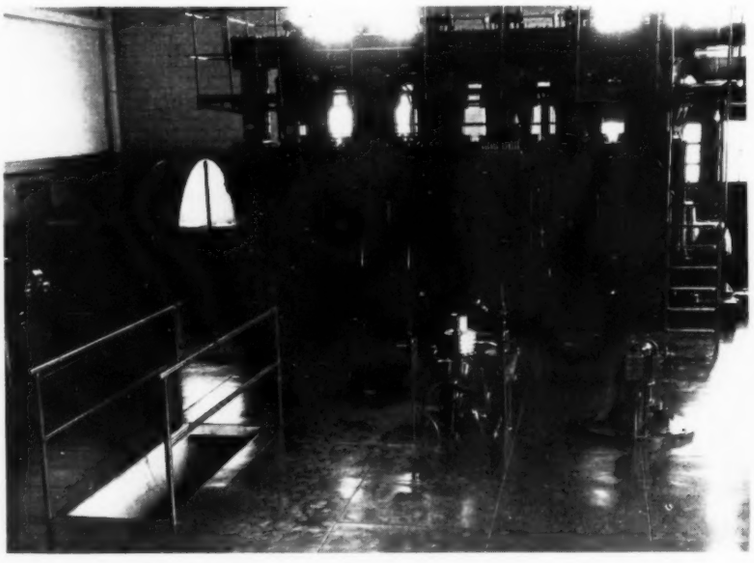
Developments toward a remote control operated gas line compressor station are in an experimental stage. One such station is in the midst of a test in the Mid-Continent. Its turbo blower is similar in many respects to a multi-stage centrifugal pump. It is directly connected to its motor and totally enclosed in a pressure tight shell tied into the main line. The gas goes through the motor to the turbo which increases the pressure and delivers into the main line.

The portable pipe line station has witnessed a wide development during the past few years because of its portability and high salvage. For the most part these units are engine driven reciprocating pumps and may be moved quickly from one location to another on one or more trucks, depending on the size. Gas, gasoline or crude oil are used as fuel.

Both the pump and engine are bolted to separate H-beams on the larger units and when set up the pair of skids are bolted together to make the unit more rigid. Where the units have a period of semi-permanent service they are frequently set on concrete foundations, but in most instances they are set on skids permitting almost 100 per cent salvage when a permanent installation is made or when the unit is moved out for any other reason.

Several engineers are looking to still another method in station operation in that they are considering the construction of power generating plants, preferably Diesel plants, and building high lines along the right of way. Such stations would have motor-driven reciprocating or centrifugal pumps.

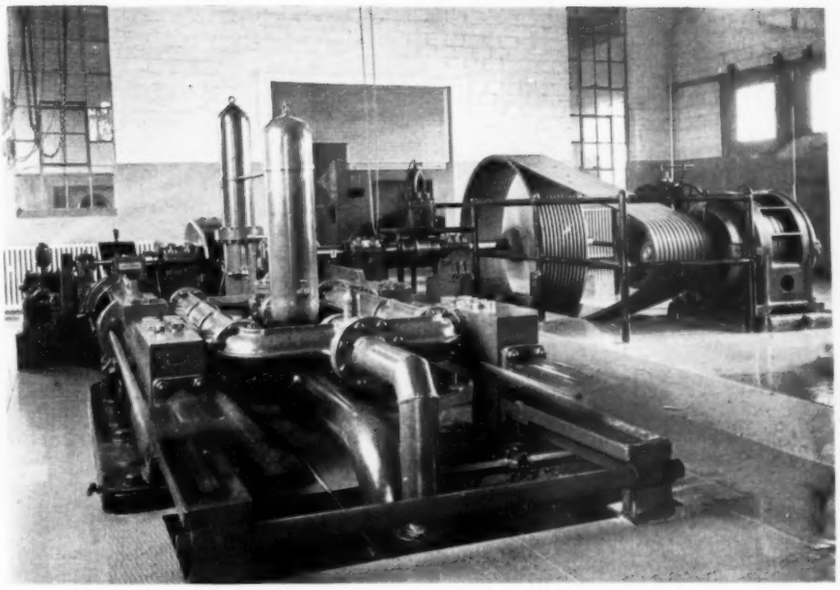
Automatic stations have another field of application where small units are required to handle a small amount of oil daily. Most of these installations are in old areas where a small amount of oil is gathered daily and the original temporary field stations or later permanent stations have been removed.



Modern Diesel plant with a station basement.

Such installations are usually motor-driven reciprocating units operated through mercury switches and protected against the common sources of trouble. The stations have a working tank, which when filled to a predetermined level, cuts the motor in through the mercury switches. When the tank is pumped down to a low level the station is automatically shut down.

While these changes have been in the process of development the generally accepted types of prime movers and reciprocating pumps have been constantly improved and changed to meet various operating conditions. At the same time the equipment is giving a more satisfactory service with less down time. The reciprocating pumps have been equipped with special packing boxes for service on gasoline lines.



Motor-driven reciprocating pump unit.

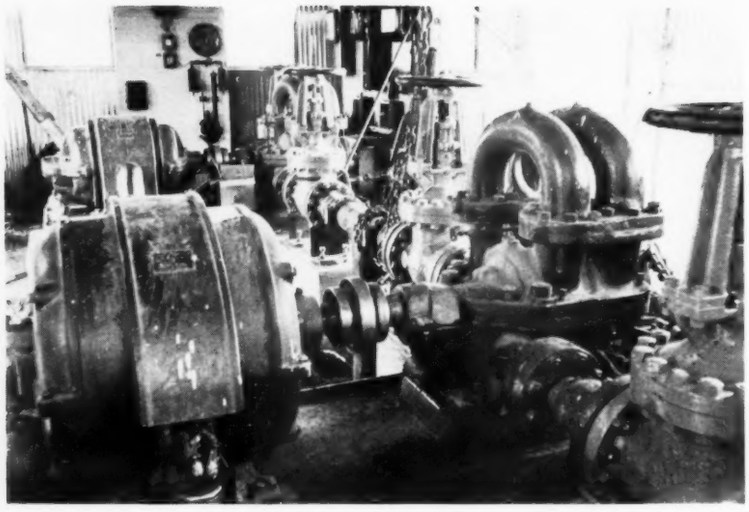
Design of both oil and gas line stations have, in recent years, undergone several notable changes. A great many of the newer stations are built with full and semi-basements. All station piping is carried along the walls of the basements and on the ceilings, making the piping more accessible for repair and making it possible to have a smooth station floor free of conduits. Stations, too, are designed to afford more natural lighting and better ventilation. Both the structural steel and the brick stations are designed to permit relatively easy expansion of the stations when necessary.

Improved operating methods take into consideration better care of the fuel oil as well as lubricating oil at Diesel-powered stations. Virtually every company is giving more serious consideration to lubricating and fuel problems with the result that engine wear is further reduced.

Water circulating systems have been greatly improved by the closed type systems. These systems use a heat exchanger built around the pump's suction line to cool the jacket water. This method has been a big money saver at stations where water conditions were extreme. Only a small amount of make-up water is required daily to keep the system filled and the low temperature of the oil is sufficient to cool the hot jacket water before it is returned to the engine.

The results of the changes in methods and practices has brought about a savings in maintenance costs and operating charges. The improved conditions at stations makes for a more satisfied operating personnel with fewer turnovers and the stations are more attractive in appearances.

Panhandle Eastern Pipe Line Co.'s station in Louisburg, Kan.



General view of station interior during construction with instrument board in background and controllers in right background.

Pressure Volume Differential Operates Oil Line Booster Station

OPERATING on a pressure-volume differential controlled from another station, the Skelly Oil Co.'s pipe line department has opened the way for another method of booster station operation with the building of its Burrton, Kan., booster plant. The station is small and compact, requires no operating crew and may be placed on and off the line as required by merely pinching the discharge gate on the centrifugal pump or shutting down one unit at the control station behind Burrton.

Originally 15,000 barrels of Mid-Continent grade crude was pumped from Voshell station to the Valley Center, Kan., station through 16 miles of 6-inch and 25 miles of 8-inch, against a pressure of approximately 700 pounds. Voshell station's present equipment is comprised of two 3-inch, 3-stage centrifugal pumps directly connected with flexible couplings to 150-horsepower motors and one 4-inch two-stage pump driven by a 75-horsepower motor.

It was desired to increase the runs to 19,500 barrels daily for peak load conditions. An automatic station was the most desirable method of increasing the capacity. In the past the remote control automatic stations have been controlled and operated over the communication line paralleling the pipe line. Such a line did not follow the pipe line in this instance, but a power transmission line was close by. Engineers working on the project then designed a motor-driven centrifugal pump station to be operated by a pressure-volume differential.

This is accomplished by pinching the discharge gate on one of the pumps at Voshell which lowers the line pressure and restricts the volume of flow through the line. When this condition exists at Burrton, mercury switches in connection with an electric flow meter close electric circuits which energize the time relay switches. If this predetermined condition exists for 30 seconds, the time relay switch for No. 1 starts that unit in operation, and No. 2 unit is automatically started 15 seconds after the starting of No. 1 unit.

For the purpose of easier explanation of the station's operation assume that Voshell is normally delivering 15,000 barrels at 700 pounds with its two large pumps on the line. Assume the pressure at Burrton to be 400 pounds. Burrton station's control installations are set to cut in and start the station when the pressure at that point is 350 pounds and the volume of flow is 14,000 barrels daily.

At the normal or 15,000-barrel value the mercury switch B, as shown by the accompanying illustration, is open and set to close the electric circuit at that point on the wiring system when the pressure reaches 350 pounds. The contact on the electric flow meter is closed and remains closed so

Detail of valve installation between pumps and welded tee connection.

long as the rate of flow through the line is 14,000 barrels or above. The mercury switch (D) is for protection only in the event of a broken line and remains closed until the discharge pressure drops sharply.

To start the Burrton booster the operator at Voshell station pinches the discharge gate on the centrifugal pump, which reduces line pressure and lowers the rate of flow. The gate is pinched sufficiently to reduce the initial pressure at Voshell to about 600 pounds and at the same time restricting the volume to about 14,000 barrels. This operation reduces the line pressure at Burrton to about 350 pounds, at which pressure the mercury switch closes, making the circuit.

When this is done the relay contact is made, causing the contacts to be made which energize the time relay switches. Thirty seconds after the time relays are energized it trips the starter for No. 1 unit which goes on the line and 15 seconds later the same sequel of events follows for No. 2 relay and starter which start No. 2 unit.

During this operation, which is a matter of only two minutes, the operator at Voshell is closely observing the station's line pressure gauge. When it starts to drop steadily it indicates the starting of Burrton station and he opens the pinched discharge gate and then starts the two-stage centrifugal unit at Voshell. With all five units on the line the maximum delivery to Valley Center station is 19,500 barrels, 40 viscosity oil.

When it is desired to shut down the station the operator at Voshell shuts down the two-stage and one 3-stage unit, which restricts the rate of flow and reduces it to considerably below 14,000 barrels daily. When this condition prevails at Burrton the switch on the electric flow meter automatically opens, breaking the electric circuit to the relays and shuts down the station. Daily changes in runs might bring the pressure and volume of flow at Burrton to the value where the station is started. The time relay switches, however, prevent the station being started because the low pressure and restricted flow value must exist for 30 seconds before the station starts. So, if Voshell is operated to deliver less than 14,000 barrels against minus 600 pounds, it would not start Burrton when it went to a higher pressure and increased delivery. The time relay switches at Burrton would be energized only for the short period required for the pressure to go on up sufficiently to open mercury switch B, and set the controls so the station may be started by later dropping the pressure.

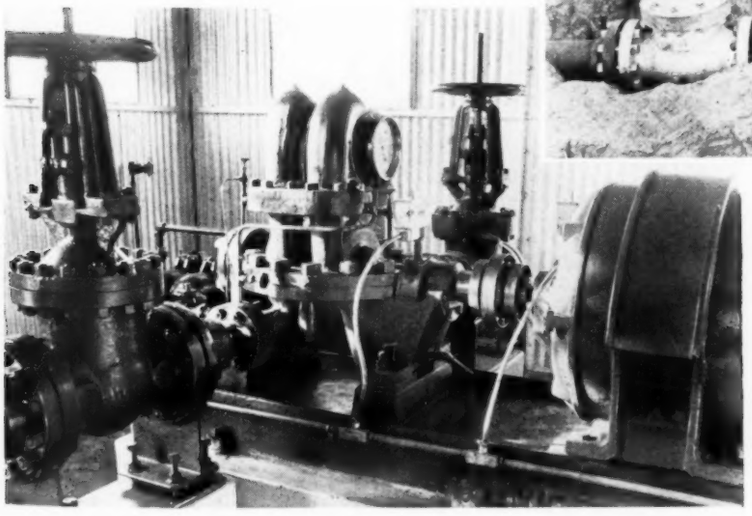
Pumping equipment at the booster station consists of two 3-inch centrifugal line pumps directly connected to as many 125-horsepower, 440-volt, 3,600 r.p.m. induction motors. On the suction and discharge of each pump is an 800-pound rising stem gate valve. Each valve is individually supported by an adjustable saddle support resting on individual concrete pedestals. The pair of saddles for each valve fit snugly under the flanges, obtaining a maximum bearing surface. These in connection with the ring and groove type couplings used between the suction and discharge of the two units, are expected to place any vibration of the units on the ring couplings and prevent it from reaching the welded and bolted connections.

The pump bearings are lubricated by the crude oil being pumped and the oil used as lubrication drains into a vertical pressure tight sump tank located outside of the station building. Inside of the tank is a small pipe and as the level of the oil in the tank rises the pressure in the tube builds up.

Two mercury switches are attached to the tube and through these the automatically-operated displacement type sump pump is started and stopped. The sump pump discharges into the main line on the suction side of the station and easily bucks normal line pressure at Burrton. One of the mercury switches is set to start the motor when the pressure in the tube is built up to a predetermined point. As the level of oil is lowered to near the bottom of the tank and the pressure in the tube falls, the other mercury switch shuts down the motor driving the suction pump.

This pump is set on a concrete foundation in one corner of the station. The motor is bolted to the top part of the frame and it drives the pump with a chain belt.

Three check valves were installed in the station piping



Left—One of the centrifugal units showing valve supports and mercury switches on bearings.

Above—Detail view of coupled tee connections between check valves.

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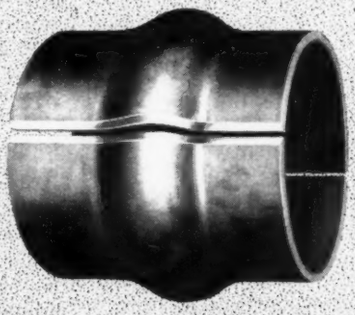

MIDWEST
WELDING SLEEVE

MIDWEST
WELDING SADDLE

★

Large stocks have been placed in each of the four Midwest pipe fabricating plants. Additional stocks are now being located in other important industrial centers.

ANNOUNCING . . .

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ANOTHER important step forward in the application of piping is announced by Midwest after two years of careful research and testing. Midwest Welding Fittings are a particularly important development because they reduce the cost of many piping systems, in addition to improving these systems.

Midwest Welding Ells, 90° and 45°. Dimensional accuracy and uniformity are exceptional. A special *compression* sizing operation finishes Ells to exact radius and sectional diameter and in perfect round. Special fixtures for machine-beveling ends assure included angle of exactly 90° or 45°. Hydrostatic test pressure is 25% greater than mill test of corresponding pipe.

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Each Ell is made from *one piece* of plate by a special process developed and patented by Midwest; there is one welded longitudinal seam along the inner circumference. Final working of the metal is at welding heat and in *compression,* thus normalizing and refining the metal in the plate and the weld—it is not extruded or stretched.

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Midwest Welding Head. The ellipsoidal form reduces the unit stress in the metal to a minimum. The long tangent puts the circumferential weld to the pipe entirely in tension—it is not subjected to shear and bending. Dimensional accuracy, the long tangent and the 45° beveled end make the application of Midwest Heads much easier and a neat appearing job is assured.

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Midwest Welding Sleeve. Used to reinforce a butt line weld between two pieces of pipe, it relieves the butt weld of any bending stress and much of the tensile stress to which it would otherwise be subjected. Transverse recess in sleeve permits its application over the conventional line weld. Each half of sleeve is slightly less than a semi-circle to assure snug fit, even when pipe has minimum allowable diameter.

Sleeves are carried in stock from 4" to 24" inclusive.

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Made in sizes from 4" x 2" to 24" x 24". Thickness is varied to suit service requirements.

• • •

Midwest Welding Fittings are made from the same material as mild steel pipe—consequently, they have the same coefficient of expansion and the same welding characteristics. On special order, they will be made from genuine wrought iron or from any of the standard alloys.

Bulletin WF-2 describes Midwest Welding Fittings in detail. Write the nearest office for a copy.

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layout. One of these is on the discharge of No. 2 pump. Two checks were installed on the main line, one on either side of the discharge line from No. 1 unit. Where the tee connection was made, three ring and groove type couplings were used to make the joints. These will not only care for a certain amount of contraction and expansion but will save stresses being set up on connections. The tee for both the main line connection and the one for the connection between the two pumps were both made on the job by the welder who used both acetylene and electric welding to fabricate the difficult job.

The station, of course, can operate only on one setting of the electrical control equipment. If it is necessary to operate only one pump at the booster station one pump may be blocked out by the gate valves. At the same time hand switches could be thrown to cut out the time relay switches for that unit. The same pressure volume differential could be used to operate the station with the single unit. If it is desired to change the pressure volume differential starting value the mercury switches and flow meter controls may be set to any desired setting.

This, of course, would require the services of someone familiar with the station layout. Its design, however, is not difficult to follow and detailed instructions showing graphically the necessary valves to close and switches to open is available for whoever may be called on to cut out one unit. To change the starting points on the control equipment would require the services of an experienced man.

A line walker will visit the station once or twice daily. On each of his visits he will check the lubrication of equipment and clean the strainers on the pump lubrication system. He will also keep the machinery clean.

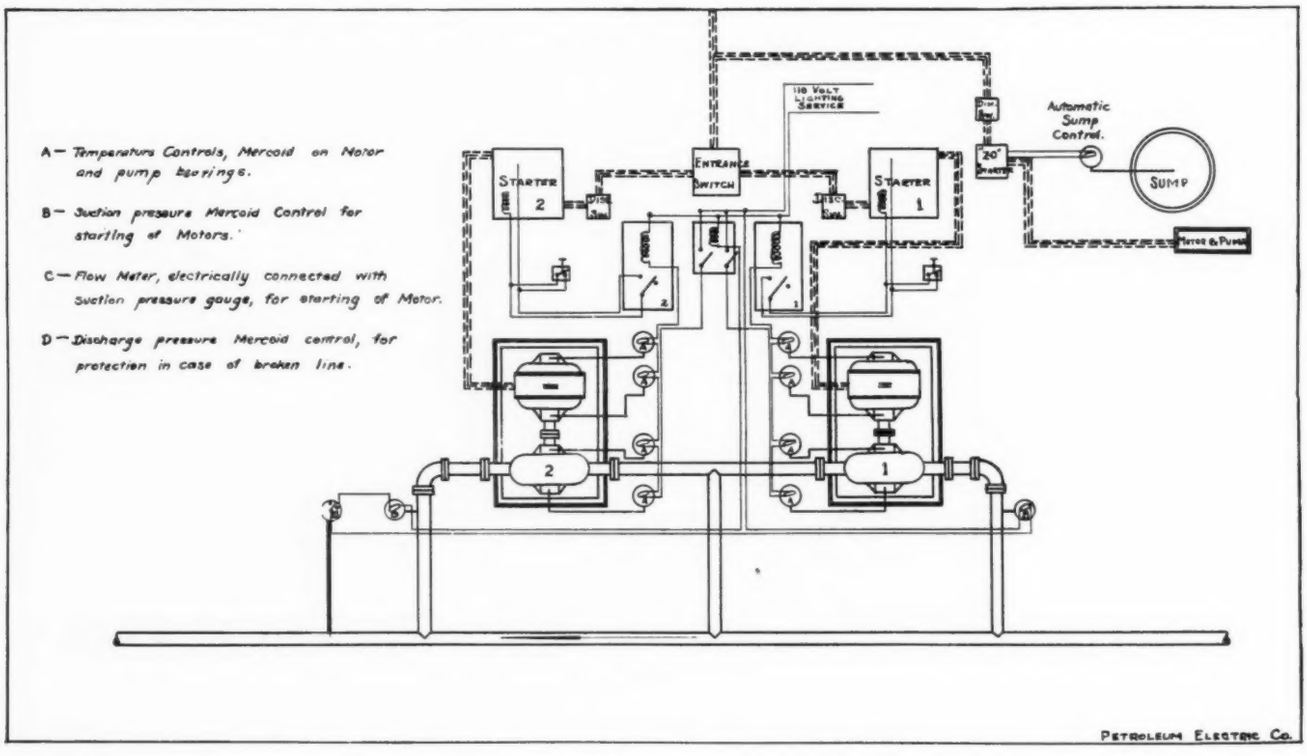
Usually station operators have several hours' notice of any increase or decrease in daily runs. Systems operated such as this would have ample time to permit the line walker to cut out one unit when only one pump was required at Burrton. Burrton is only eleven miles from Voshell and it would require only a short time to dispatch one of the crew members from that plant to Burrton in emergencies.

The station is protected on the discharge side against line breaks by a mercury switch. Should the line go out the pressure would fall rapidly and the mercury switch shut down either or both motors at whatever pressure it was set to operate.

Each bearing on both the motors and the pumps are likewise protected with individual thermal switches. The wiring for these is carried along the base plates of the units with flexible cable laterals running to the switches set over the bearings. Should any one bearing overheat, the mercury switch would break the circuit and shut down both units.

The station's instrument board is against one of the end walls of the building and attached to it is the recording electric flow meter. In addition it accommodates indicating suction and discharge pressure gauges and electrical switches. The control and electric protective equipment was designed and installed by the Petroleum Electric Co.

It is significant to note that the pressure and flow calculations made when the station was designed checked to within less than one per cent error.

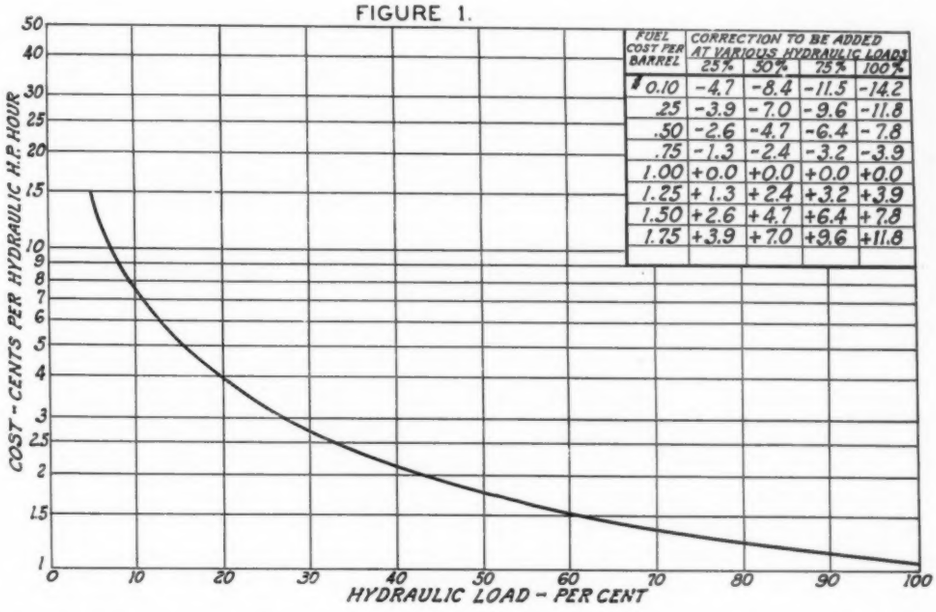

A— Temperature Controls, Mercoid on Motor and pump bearings.
B— Suction pressure Mercoid Control for starting of Motors.
C— Flow Meter, electrically connected with suction pressure gauge, for starting of Motor.
D— Discharge pressure Mercoid control, for protection in case of broken line.
110 Volt Lighting Service
Starter 2
Entrance Switch
Starter 1
Automatic Sump Control.
Sump
Motor & Pump
2
1
Petroleum Electric Co.

Layout of the Skelly Oil Co.'s new pipe line station.

A Scientific Method *for* Analyzing Oil Pipe Line Station Operating Costs

By S. P. YOUNG
Mechanical Engineer

FIGURE 1.



FUEL COST PER BARREL	CORRECTION TO BE ADDED AT VARIOUS HYDRAULIC LOADS			
	25%	50%	75%	100%
$0.10	-4.7	-8.4	-11.5	-14.2
.25	-3.9	-7.0	-9.6	-11.8
.50	-2.6	-4.7	-6.4	-7.8
.75	-1.3	-2.4	-3.2	-3.9
1.00	+0.0	+0.0	+0.0	+0.0
1.25	+1.3	+2.4	+3.2	+3.9
1.50	+2.6	+4.7	+6.4	+7.8
1.75	+3.9	+7.0	+9.6	+11.8

THE pipeline executive receives figures prepared by his accounting department which show him how much each of his pumping stations actually cost to operate. These figures are expressed as cost of "direct station operation" to which are added the indirect charges to give the total cost of station operation in dollars per month and per year. The cost is also given to him expressed as cost per barrel pumped.

It is the writer's belief that more accurate and scientific yardsticks for the determination of proper operating costs should be worked out. Then we will know what to expect of station equipment, and be able to operate it intelligently at minimum cost. In response to this conviction the following method of arriving at and analyzing station costs is hereby submitted as one way of attacking the problem.

An empirical cost curve is constructed for each oil pipe line pumping station, which shows what it should cost to operate same. This curve gives the total theoretical operating cost in cents per hydraulic horsepower hour at all station hydraulic loads from maximum or 100 per cent load down to 10 or even 5 per cent hydraulic load. (The method used in constructing this curve is explained further along in this article.)

Figure 1 is such a cost curve and for purposes of explanation represents the curve for an oil pipe line pumping station we will call "Station A" which has a maximum hydraulic load of 5,000,000 hydraulic H. P. hours per annum. This corresponds to its maximum line pumping capacity of approximately 48,000 barrels per day at 700 pounds gauge pressure. Suppose this station operated for a year at an average hydraulic load of 70 per cent. Figure 1 shows that for 70 per cent hydraulic load the operating cost should have been 1.34 cents per hydraulic horsepower hour of work done in pumping the oil to the next station. Actually, however, let us say that "Station A's" cost of operation as shown on the pipeline company's books was 1.54 cents. This is a higher cost of operation than the curve shows should have occurred. The excess annual cost actually amounts to $\frac{(1.54-1.34)}{100} \times .70 \times 5{,}000{,}000 =$ $7,000.00—quite a sizable sum.

For purposes of comparison with other stations in the same pipeline system the above performance can be expressed in terms of efficiency which obviously is $\frac{1.34}{1.54} \times 100$ = 87 per cent station efficiency.

From this same curve the station excess cost and station efficiency can be worked out for the next succeeding period of time the station is in operation and if the per cent efficiency thus arrived at is materially higher than for the previous period, it is logical to believe that the station has had attention paid to it by the management and operating personnel that has improved its efficiency, and reduced its operating cost. On the other hand, if the efficiency has declined it is a signal for an alarm bell, so to speak, to the management that something is wrong either with the station operating personnel, the field superintendent, or the management itself.

In the same manner the efficiencies and excess costs can be figured out for all stations on a pipeline system. This gives (if the basic cost curves are properly worked out) a direct comparison of station operating costs and efficiencies of the different stations with respect to each other that will enable the management to pick out and concentrate on the weak stations to bring them up to the average standard of operating efficiency of the system as a whole. Comparisons can also be made by averaging the station efficiencies of the various field districts which will indicate which field superintendents are getting the best results from their stations.

In order to be of practical use the cost curves for each station must be carefully worked out. The general method of constructing one is as follows: Take for instance the complete pumping station "A" whose cost curve is given in Figure 1. This station consists of three 24,000 barrel 750-pound Diesel engine driven reciprocating pumps with all necessary auxiliary equipment, storage tanks, manifold, station lines, buildings, etc. This station is pumping oil through a twelve-inch line to station "B".

The first step is to determine the maximum station hydraulic load expressed in hydraulic horsepower hours per annum. This will probably depend on the hydraulic capacity of the 12-inch line from station "A" to station "B" as a pumping station is usually designed with a spare pumping unit giving the pumps a total pumping capacity above that of the line.

To figure the hydraulic load, therefore, we will start with the maximum allowable line working pressure, in this case 700 pounds per square inch, and find out how much oil

can be pumped through the line at this allowable pressure.

In this particular case since we are dealing with reciprocating pumps we have to determine the maximum possible quantity of oil that will ever move through the line at 700 pounds. The flow will be at a maximum when the oil is at its highest gravity and least viscosity, which in this case is known to be 42 degrees Baume and 50 Saybolt seconds.

To the above data, viz., pressure, gravity, viscosity, size of line, we add the line distance from Station "A" and Station "B" and the difference in elevation. This is procured from the engineering department records.

Then it is an easy matter with the aid of accurate oil flow charts to figure the maximum quantity of oil flowing from "A" to "B" which in this case is 48,000 barrels per 24 hours. The hydraulic horsepower it takes to move this 48,000 barrels of oil per day at 700 pounds pressure is easily figured from any one of several accepted pipeline formulas and is 570 H.P.

Multiply 570 by the number of hours in a 365-day year (8,760) and we get practically 5,000,000 hydraulic horsepower hours energy per annum delivered to the oil to maintain the above maximum possible line deliveries.

As a check the maximum combined capacity of the pumps is figured to make sure that it is not less than that of the line, for in that event the maximum pump capacity instead of the maximum line capacity would determine the maximum hydraulic load. In this case since the station's three discharge units each consists of a 24,000-barrel triplex pump direct-driven by a 400-H.P. Diesel oil engine it can be readily seen that the line capacity governs.

The next or second step after obtaining the maximum hydraulic load is to construct cost load curves illustrated by Figure 2.

As shown there is a curve giving cost of station operation when two of the units are pumping on the line together. Also a curve giving station operating cost when one unit is pumping alone. No curve is shown of the three units pumping together as one is used as a spare and there are never more than two units on the line. Examine the cost load curve for the two units when run together. On this curve the upper point on the curve marked "Full" is arrived at by figuring what the total annual station operating costs should be if same could be operated with the two oil engines running at maximum engine load.

This figure includes all items mentioned in the Interstate Commerce Commission's form for showing station operating costs, from "Superintendence on down, through labor, fuel, lubrication, repairs to machinery, buildings and grounds, oil tanks, station lines, small tools, operation highway equipment, on to allowance, personal and traveling expenses, etc. It also includes indirect cost which latter item is the same for all loads and is taken directly from the books.

On some of these items the cost can be easily figured from well established engineering practice. For instance we know what fuel and lubricating consumption should be and can thus get totals of these items by multiplying the theoretical yearly fuel and lubricating consumption by the unit delivered costs of same. We also know what machinery repairs should cost per installed H. P. year. In figuring labor we have to take into account the particular station conditions. The same is true of auto and personal and traveling expense and maintenance of station lines and some other items.

After figuring these costs for the full load condition, assume the two units to be running at three-fourths, then one-half, then one-fourth load and figure the costs at those loads in the same manner as was done at full load.

This gives us four points through which can be drawn a smooth curve. In the same way the curve for one unit was constructed.

A smooth third or station minimum cost curve was then superimposed on the above two-unit and one-unit station cost load curves in such a way that it represents the minimum annual cost at which the station should be operated at any percentage of load.

This third curve on Figure 2 gives us the desired minimum cost figures expressed in dollars of total station cost per annum. To get same into a workable form especially for comparison with results from other stations, it is best to transform the result into a curve which will give station cost expressed in cents per hydraulic horsepower hour.

This is done in the third or final step by dividing the annual costs on this station minimum cost curve by the respective hydraulic H.P. hours developed per annum at the various loads based on 5,000,000 hydraulic H.P. hours being developed at 100 per cent hydraulic load for this particular station. (Arrived at in Step 1.)

This gives us the final cost curve as shown in Figure 1. Note that a vertical logarithmic scale is used to give the curve a more workable shape.

At first reading it would appear to be a tedious and complicated task to construct a set of curves for 50 to 100 pipeline stations on a large pipeline system. Such is not the case, for if the man to work up a set of cost curves is an engineer who is familiar with actual pipeline conditions, many of the cost items which cannot theoretically be figured with any degree of accuracy can be quickly estimated within very close limits. There are also many shortcuts that can be taken after curves of representative stations are carefully worked out in constructing curves for stations similar to them in characteristics.

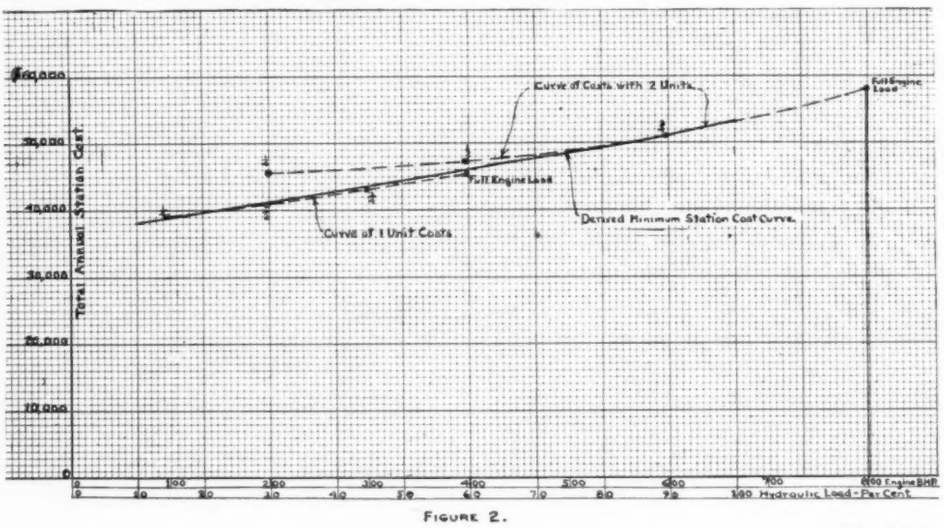
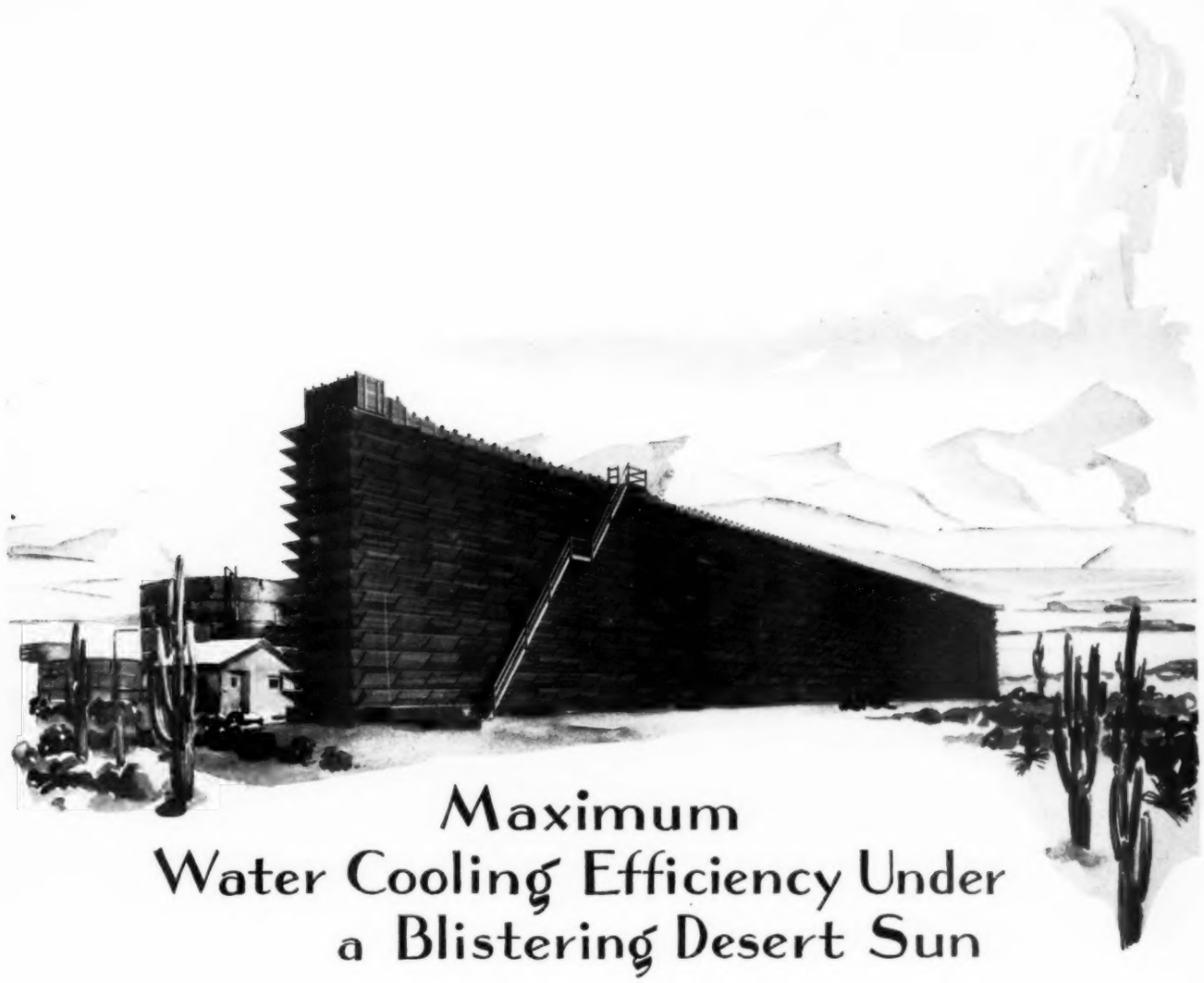


FIGURE 2.



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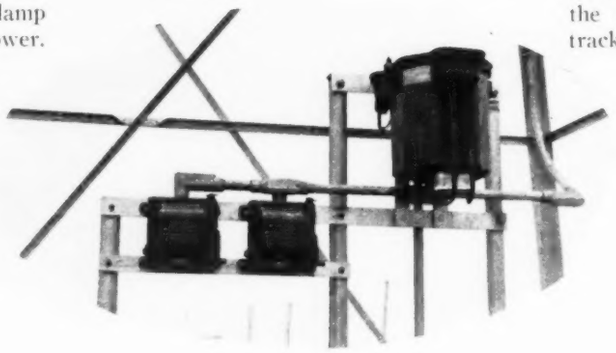
Flood Lighting Gasoline Tank Farms

WHEN the Great Lakes Pipe Line Co. built its terminals located at principal cities along the route of the gasoline line coming out of the Mid-Continent and terminating in the Great Lakes region, a new system of illuminating tank farms was developed. Possibility of prowlers entering the tank farm and causing fires made it desirable to have the entire farm illuminated. As a result the transporting company installed flood lighting towers at each terminal.

Although one of the smaller of the installations, the Kansas City, Kans., terminal is typical of the remainder. Seven floating roof tanks are located at the terminal, two being used as working tanks and the others for storage and Ethyl blending tanks.

These are adequately illuminated by two flood lights on the tower. These 24-inch lights are rated at 2,000,000 candle power and an idea of the illuminating power of them may be gained by comparing them to the average automobile lamp which is rated at 32 candle power.



The tower is 55 feet high and meets the same general specifications as those required by the Department of Commerce for use as aviation service. They are designed to withstand a 100 mile per hour wind pressure and have a platform at the top large enough to accommodate two lights and permit a man to make adjustments or repairs. They are bolted to the four three-foot square concrete blocks serving as foundations and are braced with strap iron.

Each light accommodates a 1,500 - watt lamp and each is equipped with a visor, adjustable sockets and reflectors. Both the lens and reflectors are made of ground glass. With these adjustable features the lights may be adjusted to illuminate the desired area.

At Kansas City a shaft of light 200 feet wide and 1,500 feet long spreads over the tanks and the visors bring the light down to 10 feet above the roof of the last tank.

All of the wiring is underground and the weatherproof switches are located on a board fastened to the tower to permit individual control of each light. At one terminal the system is connected to an automatic timing switch to automatically cut the lights on and off.

The Chicago terminal has the largest flood lighting system with a battery of 10 lights located on a 70-foot tower. It too has an individual control switch for each lamp.

The same general system is used to illuminate the loading racks at each of the terminals. At all terminals except the Chicago terminal two lights are sufficient to illuminate the racks and considerable of the trackage approaching the racks. Ordinarily the loading rack lights are located on a pole and so adjusted from an angle to do away with shadows and prevent blinding of rack workers and train crews.

In addition to making it more difficult for prowlers to enter the tank farm the flood lighting does away with the hazards of carrying lights about the farm and better illuminates any stumbling hazards. The light is powerful enough to permit easy reading of the gauge poles on all the tanks.

(Top to Bottom) Battery of lights illuminating Chicago farm containing six 82,000 and four 30,000 barrel tanks. Control switches on tower. Kansas City tower and tank farm.

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Lubrication Important *in* Coupling Maintenance

HIGH and slow speed machinery whose shafts are connected by flexible couplings usually receive careful attention to reduce maintenance costs and prevent development of costly trouble at critical periods. The couplings, however, sometimes fail to get the periodical inspections recommended, possibly because of their rugged construction and their ability to stand up under severe service, although sturdy couplings cannot operate indefinitely without lubrication, their major item of maintenance.

Usually the couplings give some warning indicating impending trouble, either because the coupling lacks lubrication or because the shafts it is connecting are out of line to a greater degree than the coupling is designed to care for. If permitted to continue, the coupling will eventually fail and cause the shutting down of machinery at a critical time. Especially is this true of couplings on circulating water pumps. Such units are usually located in a pit away from the station proper. If they fail to receive proper care, the couplings may fail and the pump stop, possibly causing serious damage before the failure is discovered.

Maintenance of self-aligning couplings usually reduces itself to periodical inspections to make certain the coupling contains a sufficient amount and proper grade of lubricant. If it loses its lubricant, the cause of the loss of oil is ordinarily found to lie in the failure to tighten the coupling flanges or the oil plug.

While a self-aligning coupling will care for a certain amount of misalignment, the coupling is not intended to serve as a universal joint. It is always possible to align new machinery accurately, but frequently machines will get out of alignment to a more or less extent. When this occurs the shafts will show parallel misalignment, angular misalignment or a combination of both. The same condition may be prevalent when the machines are set. The flexible coupling will care for a certain amount of this, but machines should be in accurate alignment when installed and the self-aligning coupling used as a safeguard against damage should the shafts become misaligned.

In order that they may function as intended, a few minutes care should be given them every two weeks or once a month. Self-aligning couplings are so designed that they will not "throw" oil if the flanges of the coupling are bolted tightly and the oil plug pulled down tight, and therefore little oil is necessary as make-up lubrication.

When the coupling has sufficient oil, the inner circumference of the hubs and gear teeth are in an oil bath under pressure. This centrifugal pressure, built up as the coupling rotates, throws the oil into the gear teeth, thus having a film of oil between each pair of engaging gear teeth.

As long as good lubrication is present there will be an oil film present when gear teeth engage. The thickness of the film depends upon the lubricant's viscosity and the pressure. Experiments have been made which show that a pressure upward to 6,000 pounds per square inch did not entirely squeeze out the oil film.

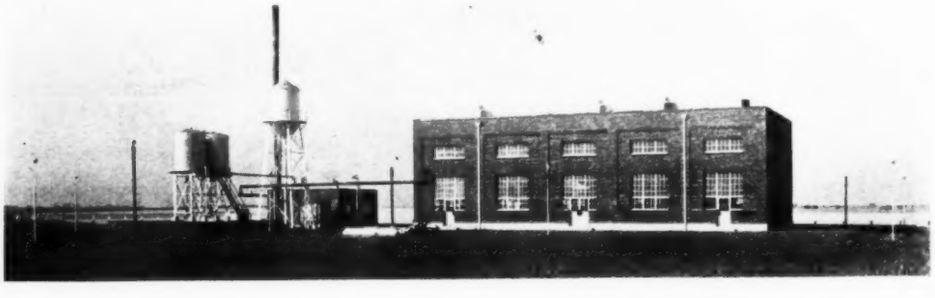
It is recommended that a lubricant no lighter than 600W or no heavier than Crater Compound be used. Good grades of motor oil should not be used only in emergencies, and then only as temporary measures. It evaporates too easily and causes rapid wear of the gear teeth. When the latter become dry, then the coupling appears to permit the gears on the shaft to slip beyond the gears on the hub. Construction of the coupling, however, will not permit such to happen, but if lubrication is neglected the teeth will wear down rapidly.

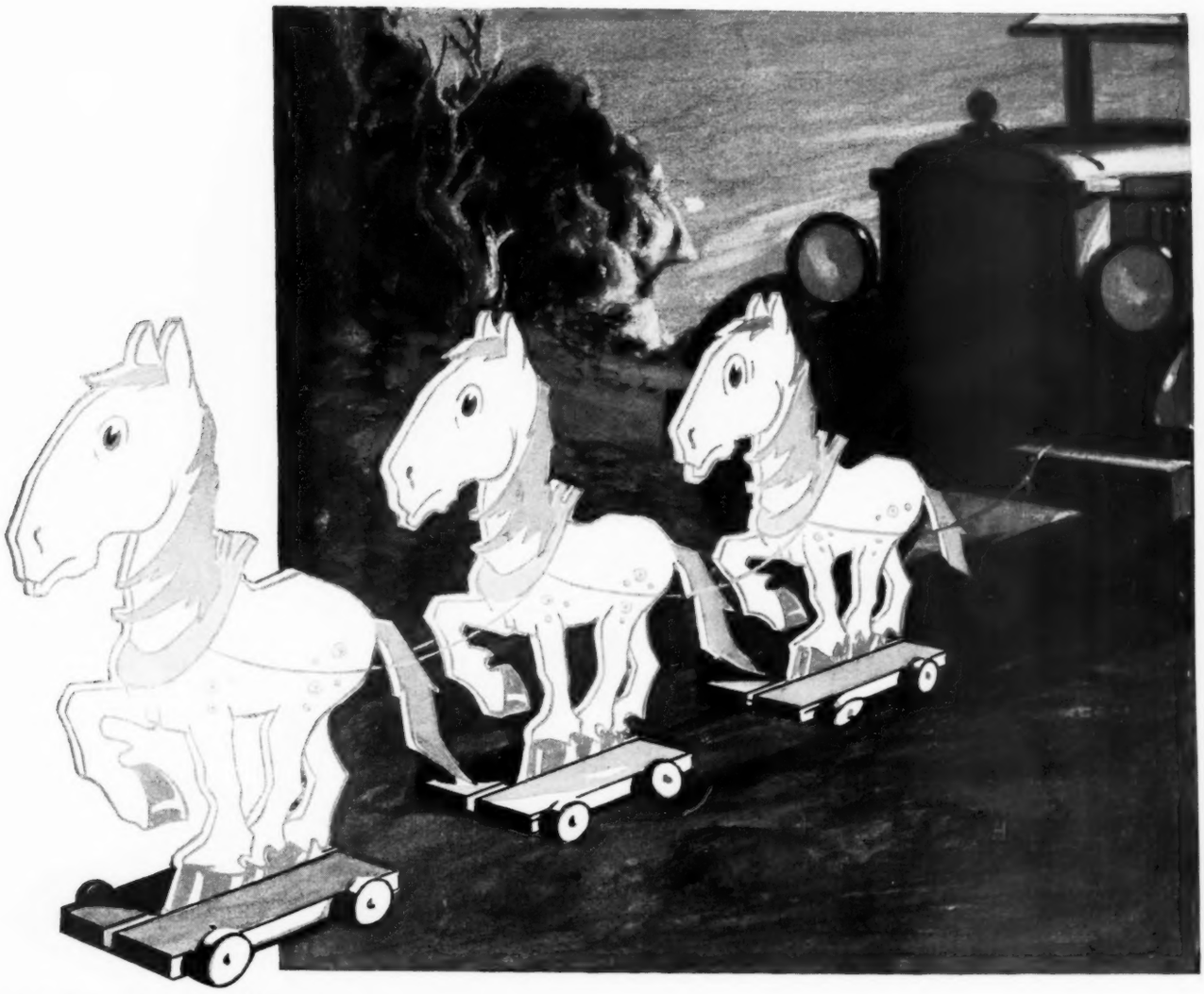
Most greases are not a satisfactory lubricant for the couplings because the centrifugal force will throw the solids to the outer side of the coupling as a centrifuge and prevent lubrication. The solid material will pack in the oil space and accelerate wear. Most any good gear grease, such as used in pipe line stations, is a satisfactory lubricant.

If the coupling is operated at high speed its lubrication should be more carefully watched than one running at slow speed. The operator after a few checks becomes familiar with the oil consumption of the coupling, but in the beginning it is better to over-lubricate than under-lubricate. When more than the required amount of lubricant is put in the coupling, the excess will run out when the coupling is at rest.

Frequently a coupling will throw oil when it is first placed in service, and usually this is due to one of two conditions. Either the oil plug has not been pulled down tight or an over-supply of oil has been poured in.

It is well to make certain that all couplings have been lubricated when they are installed. After this has been determined, the flanges should be securely tightened and the oil plug pulled down tight. Whenever a coupling is taken down its sleeve flanges should be thoroughly cleaned and the gasket examined and replaced if faulty.





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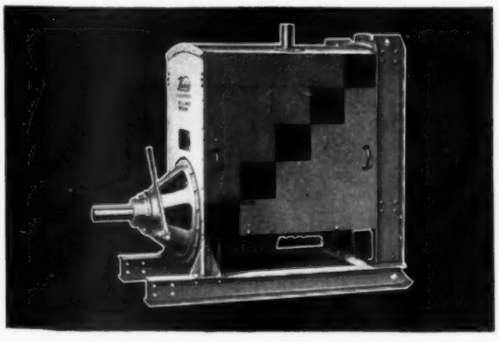


The Super Four Spudding Unit

On the job—it takes real horsepower, not paper horsepower. To prevent costly shutdowns, Waukesha Engines are conservatively rated. They actually deliver real horsepower...not paper horsepower. The utmost dependability is built into each rugged part by twenty-five years' specialized experience. Bulletin 827 shows where and how Waukesha Engines are used. Waukesha Motor Company, Waukesha, Wis.

10

WAUKESHA ENGINES

Oil Engine Piston Rings

By A. A. HARDY, *Engineer, The Prairie Pipe Line Co.*

THE importance of the part which piston rings play in Diesel engine operation is recognized, of course, by all oil engine experts. It is well, however, to emphasize this importance. Piston rings that do not form the required seal allow the gases of combustion to escape from the cylinder, thus lowering the mean effective pressure with a consequent loss of power and an expensive drop in efficiency of the engine. Along with this drop in efficiency, the hot gases, in escaping from the cylinder walls, rob these walls and the piston of lubricating oil, which results in excessive wear of expensive cylinders or liners and pistons. Any excessive wear in a modern industrial power plant is an economic waste. There are other minor effects of poor piston packing, such as increased oil consumption, carbonization, over-heating, and other indirect results, but the main considerations are loss of power and excessive wear.

In this article we shall confine ourselves to piston rings as used in Diesel engines, for other types of prime movers present different types of problems and require separate consideration. For example, the piston, and consequently the ring, in an automobile engine is much more easily lubricated, due to its shorter stroke and smaller working surface, than in the Diesel engine, and the difference in the problem of lubrication is fundamental in piston ring consideration.

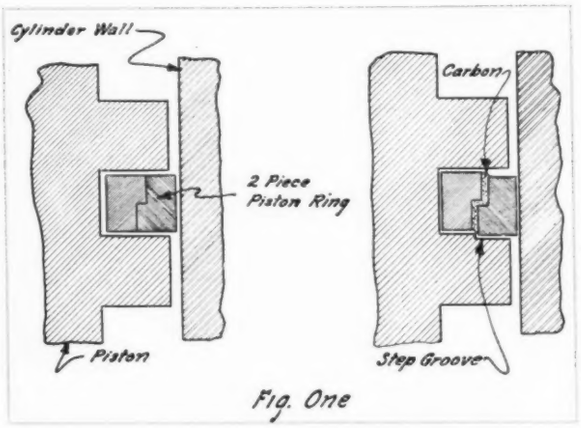


Fig. One

In the manufacture of piston rings, one of the main considerations is to so design the product that it will have equal radial pressure outward against the cylinder wall at all points along its circumference. The first piston rings were made by cutting or slicing the rings from a long cylindrical casting or ring pot of proper wall thickness and of a diameter slightly larger than the diameter of the cylinder for which the rings were intended. A segment of this ring was then cut out so that it could be compressed to the required size. This method of manufacture gave a ring that had radial tension but, due to the fact that after compression to the required size the ring was no longer a true circle, the outward pressure was not equal at all points along its circumference. This pressure was greatest at the points of the ring and least 180 degrees from the cut. This resulted in excessive wear of both ring and cylinder at the ring points and blow-by at the opposite position.

The ring just described is the concentric ring; that is, its thickness is the same at all points. In order to remedy this fault of unequal tension, the eccentric ring was suggested. In this ring the radial thickness varies from a maximum 180 degrees from the points around the ring to a minimum at the points. This ring, when properly made, gave the desired uniform pressure but, due to its unequal cross section, it was found to hammer the ring grooves out of true, which resulted in breakage of the ring. Also due to its unequal cross-section and the necessity of making the ring grooves of equal depth in the piston, a pocket was formed behind the ring at its thinnest point, which pocket allowed the gases to more easily escape from the cylinder and also provided a space for carbon to collect, with the result of a stuck ring. A reversion was then made to the concentric ring and various methods have been developed to attain the desired uniform radial pressure. This brings us to the modern ring in use today.

Perhaps the simplest method of attaining this result is to peen the inside surface of the ring. At first this was done by hand, but machines have now been developed that can do the work with exact control. Peening should be done with maximum concentration at a point 180 degrees from the points and then tapered down to a minimum at the points. This is accomplished equally well in two different manners. One method is to strike the ring with blows of equal intensity, but to vary the distance between them. The other method is to keep the distance between blows constant but vary the intensity of the blow. A ring made in this manner is called a "hammered ring" and should be made from a casting whose original diameter, allowing for finish only, is the same diameter as that of the cylinder for which it is intended.

There are other methods of attaining uniform radial pressure which are perhaps not quite so simple as the "hammering" method but which, when properly done, are effective. One such method might consist of cutting the ring from an oversize casting, then removing the segment, clamping at the required diameter, re-turning, annealing, then finishing by grinding. Another method employs oversize castings which are slightly elliptical in shape, so that when the segment is removed and the ring compressed to size, a true circular form is attained.

Cast iron is the most common and the most practical material for this purpose. It should be remembered, however, that a haphazard selection of material can never be conducive to consistent results. The iron used should be a close-grained, tough gray iron with uniform graphite distribution and with a well-defined pearlitic matrix. Careful selection should give a material that will wear well and will withstand breakage. Other materials, such as bronze, steel, alloys of cast iron with manganese, nickel and chromium, have been used with varying degrees of success. Swedish iron has also been extensively used and gives excellent results. Some piston ring manufacturers are also recommending a softer cast iron, high in graphitic carbon, the purpose of which is to transfer the wear from the expensive liner or cylinder to the comparatively inexpensive ring. This purpose can be very practically accomplished, but care should be taken that the iron used is not so soft that wear on the ring is excessive.

The one-piece snap ring, regardless of type of joint, cannot be made to give a total seal at the cut. To remedy this condition, the various manufacturers have made various and ingenious multiple piece rings. Such rings, in order to attain the desired seal, must present continuous surfaces both to the cylinder wall and to the bottom or skirt end of the ring groove in the piston. It is not necessary that they present a continuous surface to the top side or head end of the groove, as the ring is forced away from the head end of the piston under either compression or expansion of the gases in the cylinder. These multiple piece rings are made in two or more pieces, but for our purposes the only practical one to consider is the two-piece ring.

The use of such rings, properly designed, is particularly advantageous in worn cylinders where the piston clearance is excessive. Because of the fact that worn cylinders are always larger at the head end of the cylinder than at the skirt end, it is necessary to provide excessive end clearance with even new one-piece snap rings, resulting in escapage of gases with all the attendant evils. By properly fitting a two-piece ring of correct design, this blow-by can be practically eliminated in a worn cylinder, providing the cylinder is not scored or worn oval to any great extent. In this manner the life of a piston and cylinder can be economically extended and the expensive remedy of reboring and fitting an oversize piston can be economically postponed. When used in this manner, one two-piece ring per piston will aid materially, although more satisfactory results will be obtained by using two. They should be placed in the third and fourth ring grooves from the head end of the piston, or even farther down than this. When placed in the top grooves next to the fire they become very quickly fouled with carbon and inoperative due to the interstices resulting from their multiple construction.

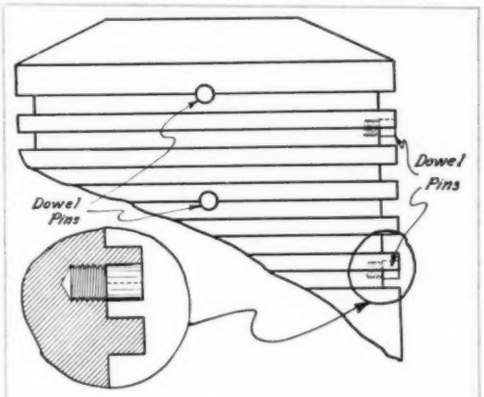


Fig. Two

Some piston ring manufacturers recommend that the two-piece ring be installed on new pistons in new cylinders. By doing this, blow-by is more nearly prevented from the start, which is conducive to better lubrication and consequently less wear. This thought is worthy of consideration.

One objection to the two-piece ring is that certain types will wear a step in the lower face of the ring groove. This effect is shown in figure one. Another feature that can be objectionable is a small and delicate cross-section in one of the members, which, of course, would be subject to breakage. Such objectionable features can be and are eliminated by proper design.

Doweling piston rings—that is, pinning them so the joint will remain at one particular point—is, at the best, objectionable. However, it becomes necessary, under some conditions, to resort to this measure. Such dowels should be about the same diameter as the groove is wide and should be placed half in the groove and half in the piston body, as shown in figure two. The best possible method of making dowels is to machine the dowel in the piston groove as the piston is being made. Some manufacturers equip their pistons in this manner. If not so equipped, the piston should be drilled and tapped and a bronze or brass pin screwed tightly in position. Bronze or brass is far better for this purpose than steel or iron, both because, should the pin become loose and come out, the cylinder and piston will not be so badly scored, and because the coefficient of expansion of bronze or brass is about twice that of cast iron or steel. This will result in a tightening of the screw in the piston as it heats.

It is not at all necessary to dowel the rings in a vertical four-cycle engine, and some authorities believe it not to be necessary in four-cycle horizontal engines. This question can best be determined by the operation of the engine in question. If the ring joints consistently line up, thus offering the gases a comparatively easy access from the cylinder, dowels should be used. Trouble of this kind is not always experienced. With two-cycle engines, however, it is usually necessary to pin the rings so that the joints will not pass over the ports in the cylinder wall. If allowed to pass over these ports, the ends of the ring will deflect, due to the sudden escapage of gases, and they will be caught on the edges of the ports and broken. This is particularly true of two-piece rings and they, in all cases when used in two-cycle engines, should be doweled.

The installation of piston rings is a relatively simple procedure. However, it is well to give the matter some attention, for a ring improperly fitted can be a source of almost unlimited trouble. We shall not consider the various and ingenious methods of removing and placing the rings on the piston. This can be accomplished by a mechanic with any experience at all. We shall, however, list a few items worthy of consideration.

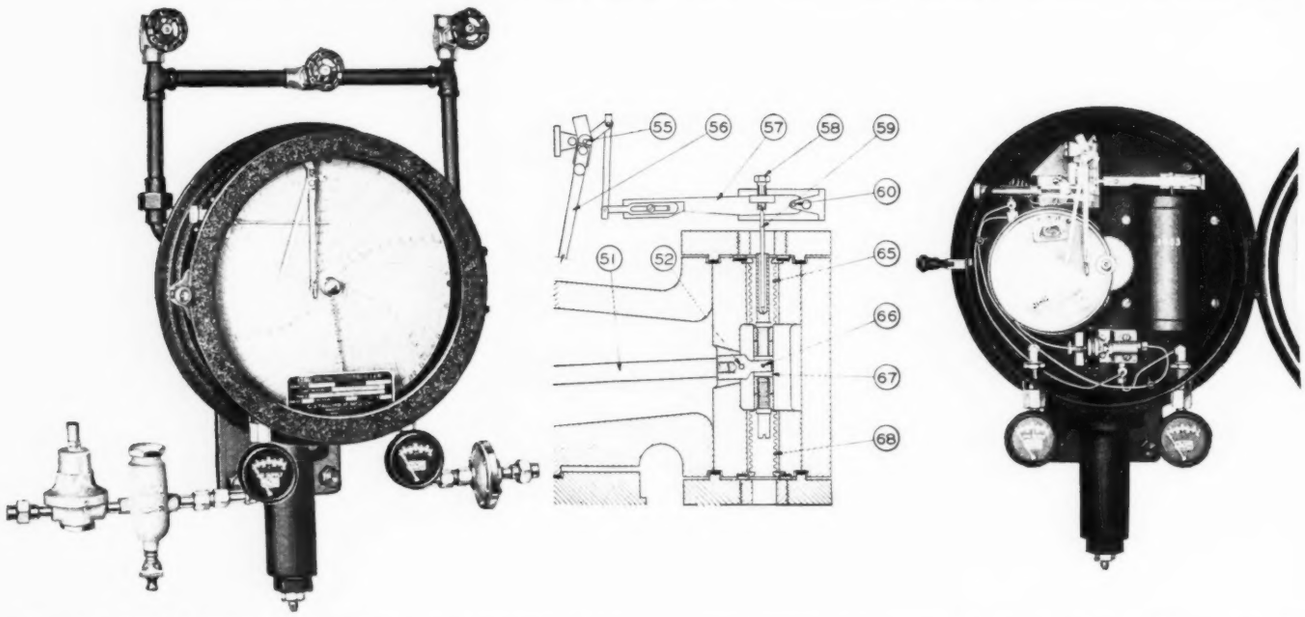
In fitting the rings for end clearance, they should be placed in the cylinder with the piston removed in the same relative position as they will occupy when in operation. End clearance should then be given and should amount to .003 inch per inch diameter of the cylinder. It should be borne in mind that clearance on a bevel cut ring should be measured at right angles to the cut and not parallel to the plane of the ring.

In fitting rings for side clearance, a careful inspection of the grooves in the piston should first be made, making certain that the grooves are free from carbon and dirt and that they are true and not worn or hammered out of shape. The rings should then be given four to five thousandths inch clearance in grooves at the skirt ends and the rings in the top two or even three grooves should be given six to seven thousandths inch clearance. If two-piece rings are being used, an additional two thousandths inch should be allowed. After being thus fitted the rings should be rolled around the piston in the groove to make certain that they will be free in all positions.

When installing either new or used piston rings, it is always advisable to run a file over the outer corners of the rings just enough to knock off the sharp edges and allow the ring to slide over the cylinder walls without scraping off the oil as a sharp-edged ring will do. It is also advisable, when it becomes necessary to install one or two new rings on a piston, to move the old rings into the top grooves, keeping them still in their old order, and install the new rings in the bottom grooves. This gives the new rings a chance to be worked in under much more favorable conditions than they would have if installed in the upper grooves nearer the fire.

As mentioned in the first part of this article, the life of the piston ring is dependent upon proper lubrication. The rings should first be properly selected and installed, then given proper lubrication. But this subject is beyond the scope of this article and deserves special study of its own.

No Pressure-Tight Bearings in TAG Flow Instruments



TO TRANSMIT the flow movement from inside the manometer pressure chamber, which is at pipe line pressure, to the recording pen outside, which is under atmospheric pressure, without friction or leakage, is a problem to which has probably been given more attention in flow instrument design than any other.

The diagram above (in the center) shows the ingenious solution by which TAG design overcomes this stumbling-block to accurate flow measurement and control.

The lever 51, which transmits the vertical movement of the float, engages yoke 67. This yoke is supported in position by two bellows, 65 and 68, one at each end. These bellows, being identical, are equally affected by pressure changes inside or outside the pressure chamber, and balance each other so that such pressure changes can cause no movement of the yoke. At the same time they allow the yoke to move without restriction up or down as the float falls or rises. The yoke extends through the inside of the upper bellows 65, enabling its motion to be communicated to the pen leverage system by pin 59.

Entire elimination of friction and the utter absence of any opening through the pressure chamber, which is sealed from the atmosphere, are exclusive TAG Flow Instrument features, making possible the full utilization of float movement in moving pen and removing every possibility of leakage.

Send for Catalog No. 1020-51, completely describing the: TAG Flow Recorder-Controllers for Liquids—TAG Flow Meters and TAG Orifice Meters for Gases—TAG Flow Recorder-Controllers for Gases—TAG Liquid Level Recorder-Controllers.

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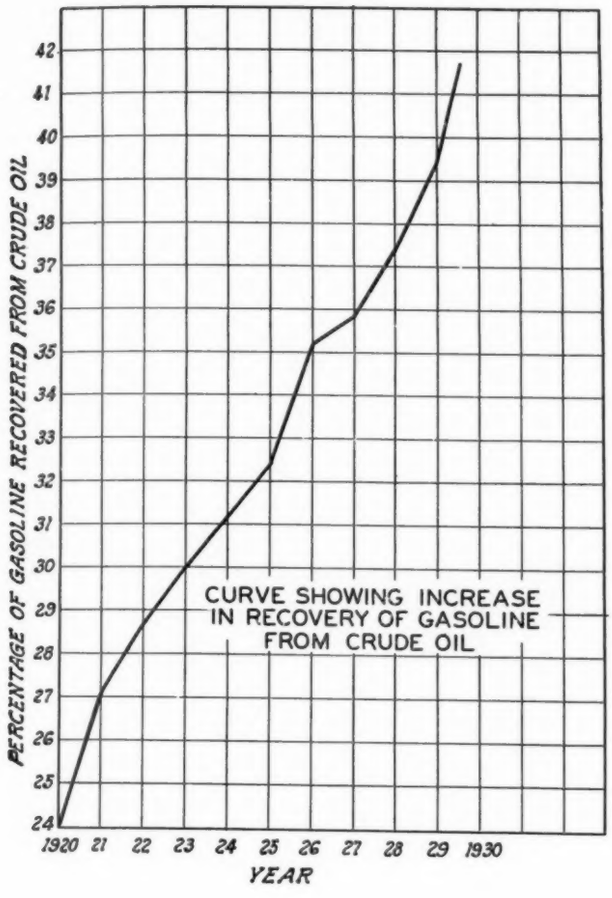
TAG FLOW

INSTRUMENTS

Operating Conditions ON Phillips Gasoline Line

By S. STANLEY LEARNED,
Engineer, Phillips Pipe Line Co.



WHILE gasoline was a comparatively small portion of the recovery from the refining of crude oil, it was not uneconomical to refine crude oil near the producing area and then to transport gasoline, kerosene, fuel oil and other products to their ultimate point of use by tank car. However, the last ten years has seen tremendous changes in refinery practice. With the use of better and more efficient cracking processes, larger and larger yields of gasoline per barrel of crude have been obtained. Figure 1 shows quite clearly this increase over the last ten years. The average recovery in ten years has increased from 24 per cent to 42 per cent. Figure 1 represents only the average of all refineries. The new modern refineries with full cracking facilities will recover from 60 to 70 per cent of the crude oil as gasoline.

Refining costs are normally much cheaper near the source of crude production than they are near the point of ultimate consumption, because:

1. Initial land costs are much less.
2. Erection costs of equipment are less.
3. Operating fuel costs are considerably less.
4. Transportation charges are not paid for crude oil that makes up refinery losses.

Furthermore, gasoline can be pumped with less friction loss than can crude oil.

Inasmuch as the Mid-Continent area produces about 50 per cent of the nation's crude oil but consumes only about 15 per cent of the nation's gasoline, it has been necessary for either the crude oil to be piped long distances to refineries at the consuming centers or it has been necessary for the refiner near the source of production to ship his product a long distance by tank car.

This necessity for getting gasoline away from the Mid-Continent led several of the larger refiners to carefully consider gasoline pipelines and resulted in the construction of several lines of some magnitude. Considering the facts above mentioned, that:

1. It is more economical to refine at producing centers;
2. Gasoline may be pumped at less friction loss than crude oil;
3. Refining at producing center eliminates the pumping charges on the losses during refining; it should be evident why this has proved an attractive means of transportation for Mid-Continent refiners.

Pipeline Developments Which Made Gasoline Pipelines Possible

Two developments in pipeline practice and equipment were instrumental in making gasoline pipelines possible:

1. The use of welded lines.
2. Developments in centrifugal pumps toward higher efficiency.

The use of welded lines has cut gasoline leakage through pipelines to a bare minimum. This item of leakage becomes one of major importance when one considers the value of gasoline.

The developments in centrifugal pump design to the point where on large deliveries high efficiencies can be obtained (efficiencies nearly equal or equal to those of plunger pumps) has allowed the use of this type of pumping unit for gasoline lines. The use of centrifugal pumps reduces the number of working tanks or of tanks floating on the line and consequently cuts losses by evaporation to a bare minimum.

With centrifugal pumps it is necessary to pump into tanks only at those points where gasoline is received into the line and at those points where gasoline is taken out of the line.

Phillips Pipeline Station and Terminal Design

Inasmuch as practically all new features of design are involved in the stations and terminals, let us consider only this portion of the system of the Phillips Pipeline Company.

Station Location

The location of stations involved the hydraulics of gasoline about which not a great deal was published. Based on experience of small gasoline lines, on tests made through 30 miles of 6-inch line, and on the experience of California operators who have numerous large gasoline lines, although short (between refineries and ocean terminals), it was found that the friction could best be calculated by use of water formulas and correcting for the difference in the specific gravity of water and of the gasoline to be handled. After the Phillips pipeline has been in operation a little longer, definite information on actual friction drop will be available.

The line is designed with a total of fifteen stations in its

681 miles of eight-inch line from Borger to East St. Louis, Illinois, with eight of those stations constructed now. The line has a capacity of about 20,000 barrels now and will have a capacity of approximately 30,000 barrels with the construction of the additional seven stations.

Station Design

In general, the stations follow normal pipeline procedure, but they are marked by two rather radical departures from accepted pipeline practice:

1. The use of gas engines direct connected through gear increasers to centrifugal pumps.
2. The use of butane as a fuel for the gas engines.

Neither of these items involved any radical engineering design but merely the application of these features to pipeline design.

The use of butane as a fuel was not seriously considered more than three or four years ago. Butane is one of the constituents of casinghead gas as it comes from the oil well along with the oil. In the manufacture of natural gasoline, a portion of the butane remains in the gasoline, practically all is removed from the residue gas, and the balance of the butane is burned as a waste product. In the last several years quite a market has been built up for butane as:

1. Gas enricher in manufactured gas plants.
2. Butane air mixture gas plants.
3. Numerous industrial uses where constant temperature and flame height are of importance.

Inasmuch as the Phillips Petroleum Company was one of the largest marketers of butane in the country and inasmuch, therefore, as it had to be transported through the pipeline, it was decided to use it as a fuel to drive gas engines which would be motive power for the pumps.

The adoption of butane as a fuel involved only a change in the carburetors of the engines to effect the proper air gas ratio, inasmuch as butane contains approximately 3,100 B. T. U. per cubic foot. The gas engines are six-cylinder, developing 260 horsepower at 360 R.P.M.

At each station there are three units, two operating and one standby, each unit consisting of a gas engine direct-connected through a turbine type gear increaser to a 3,600 R.P.M. centrifugal pump. The pumps are four-stage centrifugal developing 1,150 feet head. The coupling between the engine and the gear increaser, by means of resilient elements takes up the tendency for the engine to operate at non-uniform velocity and keeps this shock from reaching the pump which operates at a uniform velocity.

The balance of the station design follows more or less general practice.

Terminal Design

The design of terminals was entirely dependent on the methods of operation. For two main reasons mentioned below it was decided to pump no blended motor fuels ready for use:

(1) *Theft*—By not pumping a blended motor fuel, there will never be any product in the pipeline which will make a burnable or salable gasoline for those who might otherwise wish to steal gasoline by tapping the line.

(2) *Blending*—Inasmuch as the Phillips Petroleum Company who under existing conditions is the largest user of the pipeline gas, built up a large business on a gasoline of controlled volatility, wherein the distillation curve of the gasoline is altered to meet changed weather and atmospheric conditions, so that the car will have the same characteristics of easy starting, good acceleration and speed the year around, it was necessary to make provisions to pump at least five variations of gasoline. It therefore was much simpler to pump the raw products from which gasoline can be blended and make the blends at the terminals for the various customers.

The principle of slugging different products is absolutely sound for products in turbular motion. To verify this beyond question, the company conducted exhaustive tests on 3-inch lines which proved conclusively that slugging was practical.

The terminals consist naturally of nothing but storage tanks for the various raw and finished products and involve the following types of tanks:

1. Floating roof tanks.
2. Spheroid tanks.
3. Butane blimps—or vertical high pressure storage for butane.

Adequate blending pumps are provided for making the necessary finished products and for loading into either tank cars or trucks for local deliveries. Complete laboratories for the control of blending are provided.

Selection of terminal properties in all cases were made to obtain best rail facilities. The terminals at both Kansas City and East St. Louis are also located on water for barge transportation of gasoline as it becomes more interesting and economical.

Gasoline pipelines are a new innovation in the transportation of petroleum products but they are here to stay for they are economically sound. The acceptance and trial of new features in design will do much to make them more economical and workable for the changing demand of motor fuel specifications.

Storage and blending tanks at Kansas City (Mo.) terminal.

Moving *and* Placing Materials *on* STATION CONSTRUCTION JOBS

By **M. V. COUSINS**, *Engineer, United Public Service Corp.*

SINCE the weight of machinery and material to be moved and placed in the construction of a large compressor station will run at a rough estimate around 1,500 pounds for each horsepower installed and since these stations on most of the newer pipe lines run from 5,000 horsepower upward, it can be readily seen that the simple moving and placing of the machinery and material may in itself be a job of some consequence. The cost of moving 7,500,000 pounds on a 5,000-horsepower station may readily become a large item if the conditions are not the best and the most effective equipment is not used. This cost has no direct bearing on the final value of the station so that every effort possible must be made if the over-all cost is to remain reasonable. To this end it is advisable in the beginning to make a survey of the local conditions so that proper equipment may be available when the actual moving of material and machinery begins.

After the initial surveys begins the preparation for the receiving and proper handling of the machinery and materials to be used on the job. Temporary offices, tool sheds, and cement house are usually constructed as a beginning with the other buildings demanded by use and convenience following as needed.

The methods used in the actual moving of materials will depend greatly on the local conditions. If it is economically possible to construct a railroad spur to the station location it will be enormously beneficial in all stages of the work. Material handling then becomes almost entirely a matter of unloading and placing. Very often, however, the station location is some distance from a railroad, necessitating the hauling of all the material used. This is sometimes further complicated by bad roads or no roads; hilly, sandy or marshy country; and such other things as can possibly add to the worries of the construction engineer.

There is no cure-all for these difficulties and each condition must be planned for individually. Roads may have to be improved or built entirely, swampy sections may have to be filled or cross laid until the road is ready for the heaviest load it will be called on to carry. Very often where money is saved on the preparatory work of this kind it is more than lost later on due to delays and damage to transportation equipment and material and equipment being transported.

The actual moving of material usually begins with the sand, gravel and cement. Cement is usually moved on whatever equipment is available, but sand and gravel can be much more economically moved by the use of dump body trucks. The unloading of the sand and gravel from the railway car can be done with hand labor but for even moderate sized stations it will be economical to use a single or two-drum hoist with drag scrapers, leaving only a small amount for hand labor.

It is worth while to give careful consideration of the sand and gravel dumps on the job. If these are too far away from the point of usage unnecessary labor will be consumed in moving for actual use, while if too close they may interfere with the progress of other work. Cement is usually stored in a specially constructed house located conveniently to the work. Care taken in the early stages of construction will greatly facilitate the later work.

By the time the machinery, structural material, pipe, fittings, etc., begin arriving the concrete work should be well along. The unloading and moving of these materials will depend somewhat on the size and weight of the parts and the road conditions. There will usually be a large number of parts that will weigh from 500 to 5,000 pounds. For this service a stiff leg derrick will be a saving and where it can be used on several jobs it will pay for itself many times over. For unloading heavier parts it is not usually economical to use a derrick but rather the slower method of jacks, blocking and rollers.

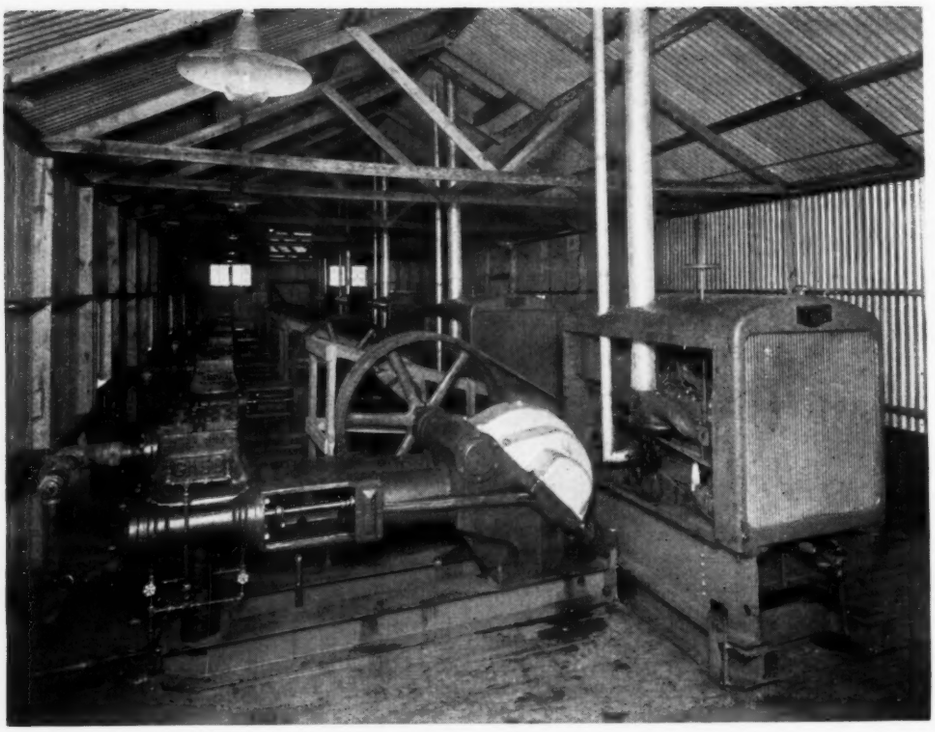
Where hauling is necessary, the lighter material can be most conveniently moved on lighter trucks, heavier material on heavier trucks with two- or four-wheel trailers such as are in general use in the oil and gas fields. For heavier loads under bad road conditions, the crawler type trailer and tractor are very valuable. Where the distance heavy parts are to be moved is not great, rollers are frequently used with a tractor for motive power. The economical limit of this method of moving can be somewhat increased by laying a track of timbers over which the parts are moved on rollers. Over country roads where the moving will naturally be slow, a properly constructed four- or eight-wheel wagon in combination with a truck or tractor may be all that is necessary.

In this connection it might be remarked that a great deal of damage can be caused by careless handling. The value of the parts damaged may be only a small part of the actual loss, for usually there is delay in getting replacements from the factory.

When possible, material should be placed in its permanent position on its arrival at the station location. With proper planning this can usually be done with most of the machinery. Sometimes, however, even with the most careful planning, it will be necessary to store the machinery on the grounds for a period of time. This should be planned for, so that when a part is needed it will be easily accessible. Different classifications of material should be so arranged that one will not interfere with the moving of another. Consideration should be given to the location of the different materials so that each class will be as near as practicable to its point of final use. If the machinery has to remain in the open for even a short time, it should be looked after carefully to prevent damage from water, dirt, etc. Most engine parts are doped with a slush compound of heavy grease on all machined surfaces before leaving the factory, but this may have been carelessly done or may have been scraped off in transit. It is a good idea to go over all parts and re-apply a coating of heavy grease wherever necessary. Electrical machinery requires special attention and should be enclosed in a waterproof cover at all times when it is stored in the open.

In all work it is greatly to be desired that the material be received as needed and that as much as possible of any material be placed permanently before it can impede the progress of other material or work. This can only be accomplished by the close co-operation of shippers and careful attention to shipping dates and routing. It is hardly necessary to say that if the engines are received early they are more or less of a nuisance until the foundations are ready to receive them. The installation cost of a station will be very materially affected by the care which is used in seeing that shipments are made so as to be received at the time needed.

Portable Reciprocating Pumping Units



Gasoline engines driving Gaso pumps in a pipe line gathering station.

ONE of the more recent methods of handling oil in the flush areas is the wide use of the portable pipe line station. These stations are both motor driven and engine driven but in the majority of instances engine powered. They are flexible in operation, economical, easy to transport from one location to another and offering a high salvage value.

With these features in their favor one or more such units may be moved quickly to a field to do its share in meeting a peak condition. Operating under such a condition, the transporter is given more time to design a permanent field station and gathering system. Instead of going into the field and making permanent installations which may be later changed and which frequently prove far in excess of equipment necessary to handle average runs, sufficient portable units are moved in. If, after they are in operation, it is necessary to make a major change in the gathering system, the portable stations may be moved to the new location in comparatively short time.

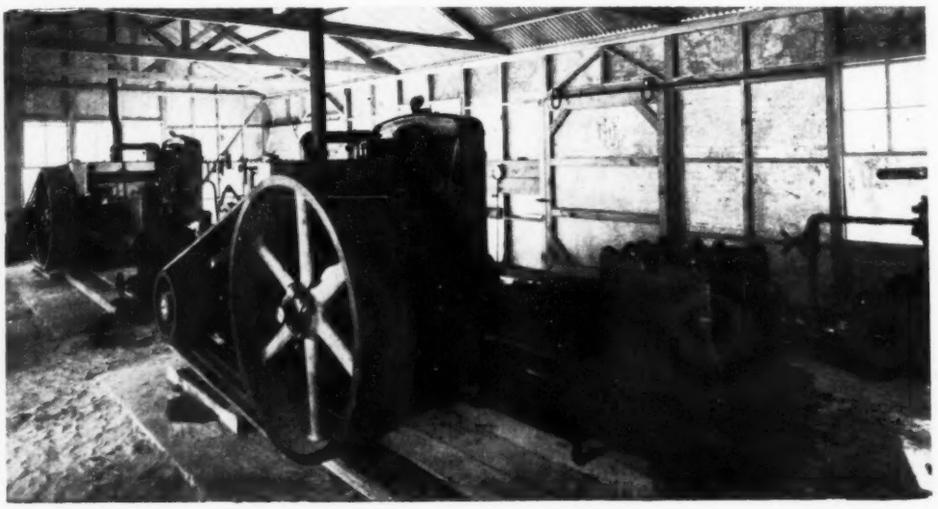
When they are moved their salvage is close to 100 per cent. In most cases these units are mounted on skids and no concrete foundation is required for their operation. They are housed in small knock down structural steel buildings which may be moved along with the remaining station equipment. All of the station piping may be taken up and moved and the fuel storage tank may be loaded on a truck and transported to a new location.

The larger of these units consist of a high speed light weight Diesel engine driving a reciprocating pump with interchangeable liners, which give it a wide range of capacities and pressures. A 92-horsepower engine weighs 5,900 pounds and burns between .5 and .6 pounds of fuel oil per brake horsepower hour. These engines burn fuel ranging in gravity anywhere from 28 to 36 degrees and are ordinarily operated with fuel drawn from the line. If the gravity of such fuel is higher a satisfactory burning fuel is made by mixing a small percentage of crank case drainage with the crude oil.

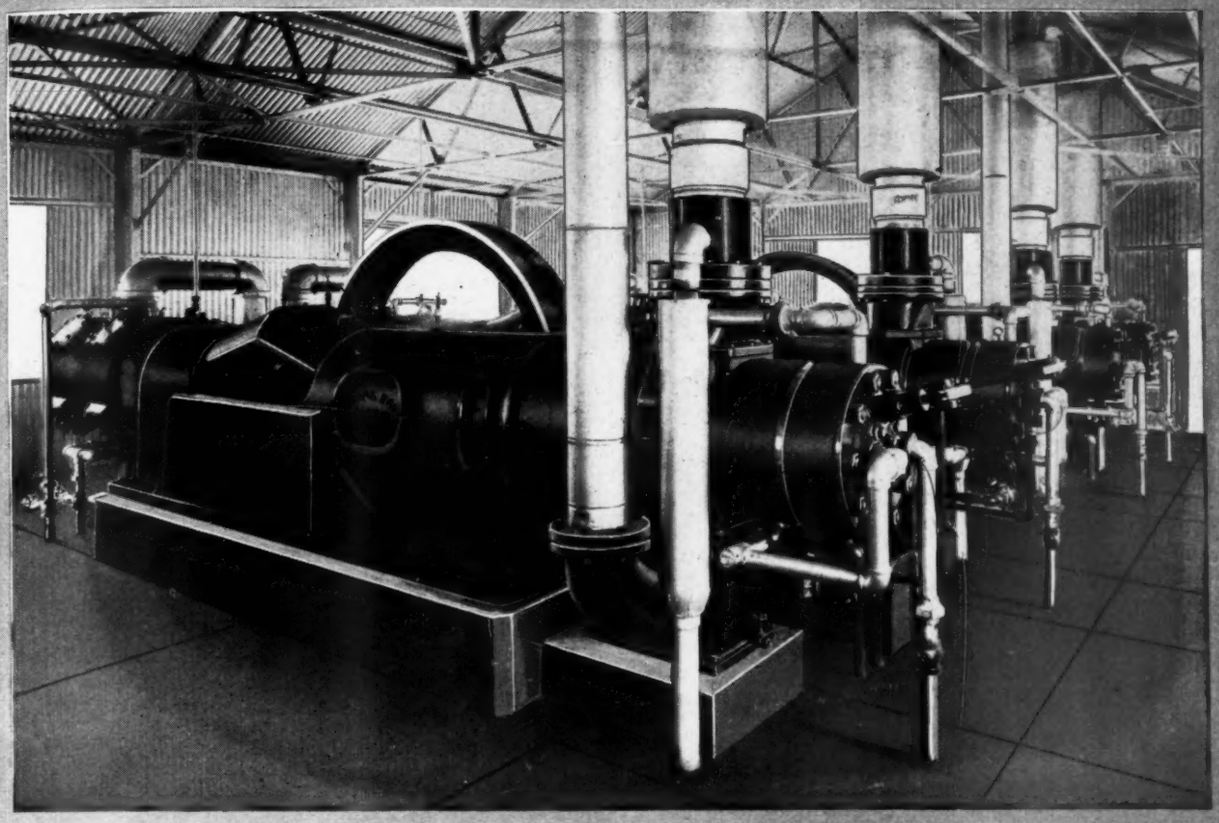
On these larger units the pump and the engine are mounted on separate sets of H-beams, usually 8-inch, weighing 32 pounds per foot. The pump and engine on their skids are set at a 90-degree angle and the H-beams, doweled and bolted together to obtain and hold alignment. Usually a V-type belt is used for power transmission. Some units are equipped with small generators to generate sufficient power for station lighting.

The only station tankage necessary is a cone bottom fuel tank. By having the cone bottom tank the fuel has an opportunity to settle. It is set on a small tower made by welding small diameter pipe. The engines are designed to use a radiator, eliminating an extensive station circulating system and also helping to solve the water problem in areas where water conditions are bad.

There are numerous installations of this type that have been in service for a considerable period of time. Each is an economically operated unit with normal wear and minor replacements.



SUPER 2-CYCLE ENGINES



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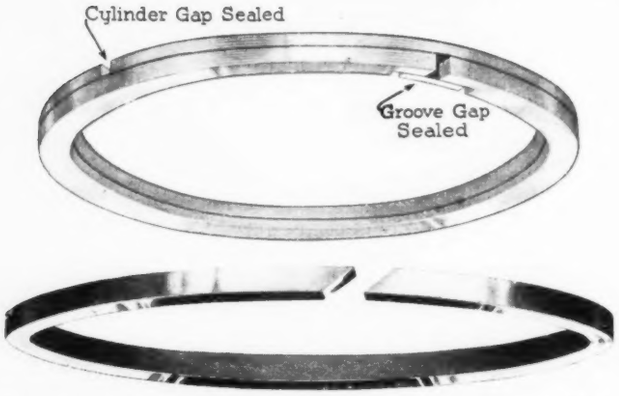

Reducing Diesel Operating and Maintenance Costs *with* SEALING RINGS

By F. BLACK[1]

WHEN a new Diesel is placed in operation, the owner is immediately confronted with the matter of operating and maintenance costs. No phase of Diesel operation is more important than the careful selection of piston rings, for these relatively inexpensive parts must hold the working pressure and convert every ounce of fuel into power if the highest efficiency is to obtain.

This fact constitutes the primary function of piston rings and is generally known. It is not, however, generally realized that in addition to inefficient operation, leaky piston rings greatly increase maintenance costs. These charges are represented by excessive cylinder wear and the eventual cost of reboring, renewing pistons, contamination of crankcase oil and the non-productive engine hours during repairs. The purpose of this article is to consider the causes and to suggest a means of correcting the trouble.

Piston rings of one-piece design, with an angle or step cut at the joint, for Diesel service have been widely used. However, an assembly consisting of a combination of one-piece and two-piece rings is now employed by many of the manufacturers. This ring application was originally developed in the field by Diesel operators, and is now common practice with many prominent users. It resulted from the discovery that one-piece rings alone may have difficulty in holding the working pressures. Due to the high operating temperature in Diesel engines, end clearances at ring joints are unusually large. For similar reasons, rings are fitted with greater groove clearance than in other services. Through these clearances the working pressures escape. Very little at first, but as wear of ring and cylinder is rapid during the first several hundred hours operation or until they have worn to a bearing, it may be said there is sufficient leakage from the start to warrant steps being taken to prevent this loss. The offending ring joints enlarge in a ratio to combined wear of ring and cylinder of 3.1416 to one. For example, starting with a minimum end clearance of .045 inch and a moderate wear of .030 inch on the ring face and .010 inch in the cylinder diameter, the total joint opening would be .265 inch. At this stage the rings are still practically new and have many times their usefulness left; the engine is also new; yet through these enlarged openings the hot gases wind their way from ring to ring and escape into the crankcase. The fitting of new snap rings only partially corrects the condition, and in a short time there is as much blow-by as before.

Furthermore, if the cylinder is worn, the rings must be fitted to the unworn section, which will cause an excessive ring gap in the worn part. Since Diesel cylinders usually show the greatest wear at the combustion end, at which point the pressure reaches its highest peak, conditions favor a maximum blow-by.

Primarily, cylinder wear is the result of the piston ring function. By maintaining perfect lubrication, both ring and cylinder wear may be controlled. But since perfect lubrication is impracticable, some wear is expected. In addition to this normal wear, the action of the hot gases, blowing by the piston as just explained, destroys the lubricant and wear is accentuated. As the ring openings at the joints grow larger, blow-by increases and abnormal wear sets in.

The application of several two-piece sealing rings to each piston to augment the one-piece ring provides a ring arrangement that will prevent compression blow-by, and in doing so will eliminate the operating and maintenance losses under discussion. Since the operators have to a great extent developed the sealing ring application, there are varying practices as to arrangement resulting from individual experiences with different types of engines and cylinder conditions. In badly worn cylinders a greater number of sealing rings may be necessary. Again, the tendency of an engine to pump oil calls for special treatment. The ring manufacturer should be consulted for specific recommendations. A practical application, however, consists of two to three ordinary one-piece rings in the fire grooves to take the extreme pressure and temperature, with the remaining grooves fitted with two-piece sealing rings.

There are several makes of sealing rings on the market. One that is being widely used in the oil fields for Diesel and gas engine service is shown in the accompanying illustrations. This ring consists of an upper and lower ring assembly with staggered joints, so that each ring will seal the gap in the other. For all practical purposes a continuous flexible piston ring is the result, without any joint openings through which compression can escape. Positive cylinder sealing results from the pressure playing on the inner bore of the ring.

Since each joint is protected against blow-by, it is readily understood why tapered cylinders do not affect the ring's sealing properties. No matter how much wear has occurred and how much the joints enlarge, the adjacent ring prevents leakage. It is on this feature the claim is based rings of this type give the same tightness in a worn cylinder as in a new one, and that more effective sealing in new cylinders is obtained than by using one-piece rings only. One-piece ring dependability may be expected with the two-piece ring illustrated, as each member of the assembly has full depth radial strength. This construction also provides individual ring bearing so as to eliminate the possibility of groove stepping.

Sealing rings are furnished to fit existing grooves, eliminating any changes to the piston. Where dowels are used, the pin is located in the upper half of the groove engaging the joint opening in the upper ring.

[1] Sales and Service Engineer, C. Lee Cook Manufacturing Co.

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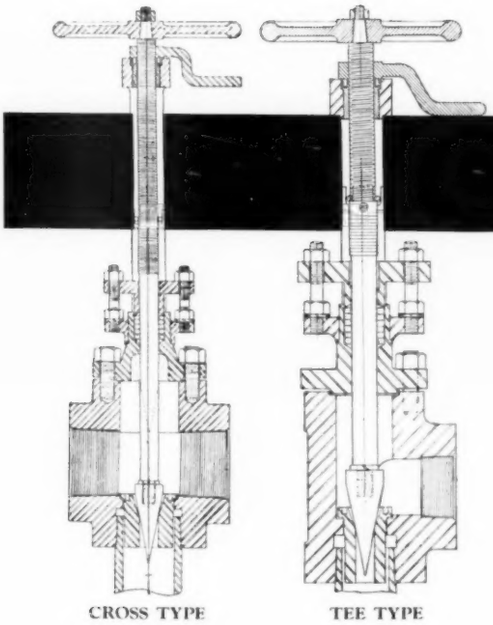

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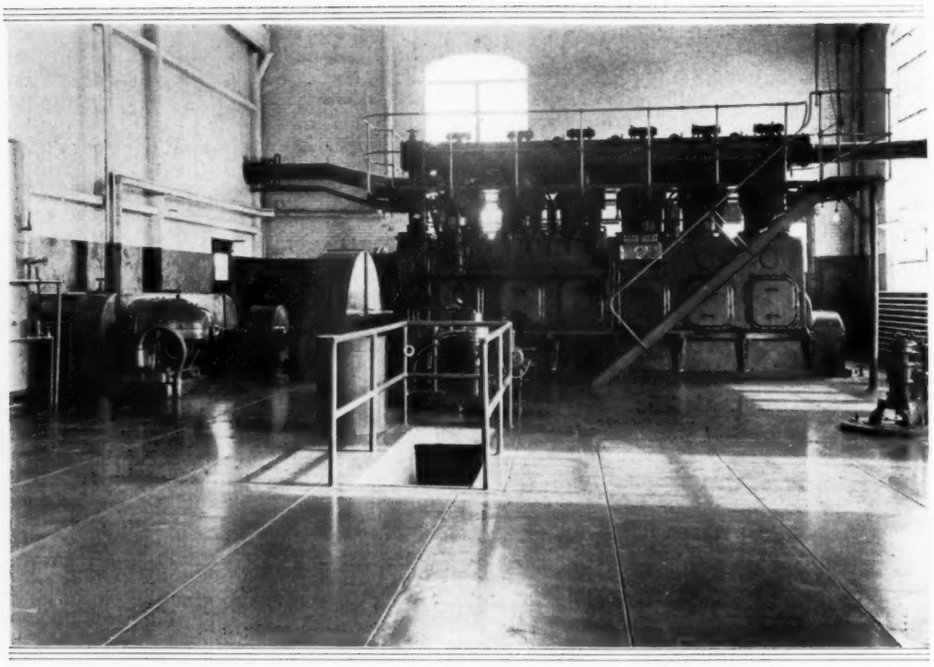

Engine room view, showing smooth and neat floor of station with piping in basement.

Pipe Conduits

A Phase *of* Pump Station Design

By J. D. McCONNELL,
The Prairie Pipe Line Co.

ONE of the greatest problems confronting the designer of pipe line pumping stations is the disposal of pipes necessary for the operation of oil engines. A casual inspection of an oil engine-powered pumping plant reveals to the layman none of the maze of lines for the transmission or handling of fuel oil, lubricating oil, cooling water and air for the engines. This is due to the fact that these items are usually cleverly concealed under the engine-room floor in conduits or tunnels; and it is part of the designer's job to make provision for these tunnels, conduits or passages on his drawings, and in some cases to detail the arrangement of lines and accessories in these conduits.

Inspection of some of our older pumping plants indicates that they were constructed without much thought being given to providing space for pipes and accessories necessary for the operation of the engines. Feeder lines and interconnecting lines are found laid haphazardly in small, shallow trenches which are covered with removable steel plates, and some lines are even buried under the concrete floor. Such methods have naturally resulted in trouble for the station operator. Conduit cover plates are found to be a source of serious accidents. Occasionally a plate is left off and a man steps into the open conduit; and oily shoes in contact with smooth steel plates have resulted in many a bad fall. The lines thrown into shallow trenches soon lose their identity, and it is often necessary to remove all lines from the trench to make accessible the one upon which work is required. The repair or replacement of lines laid under the floor slab requires a good deal of labor and leaves the floor in a scarred and patched condition.

The economy of designs or plans for pumping plants was soon recognized by pipe line officials, but the first designs were still weak in the matter of pipe conduits, owing, no doubt, to the fact that many designers were not familiar with piping problems connected with the installation of oil engines. Complaints of engine erectors were gradually answered with plans for larger and larger conduits until today the "standing-room" tunnel or basement is considered the ideal provision for pipe installations in the larger, permanent plants.

In such a basement as illustrated by the accompanying photographs it is possible to conceal all engine piping and yet have it arranged in a neat and orderly manner so that all lines are readily accessible and easily identified. In addition, this scheme provides ample room beneath the main floor level for considerable auxiliary equipment such as lubricating oil tanks, heaters, coolers, filters and small motor-driven water or lubricating-oil pumps.

The ideal arrangement for a conduit system of this kind provides a tunnel running the full length of the engine room. The space between the ends of the engine foundations and the foundation for the adjacent building wall gives ample width for this tunnel, and the height should be about seven feet or sufficient to permit a man to walk upright.

Opening off this main tunnel and running at right angles to it should be a room between each pair of main engine foundations. This room may be made as wide as the distance between engine blocks and may be carried back as far as the firewall foundation. A room of such dimensions is not necessary unless it is desired that it accommodate several lub-oil tanks and auxiliary pumps, since heaters and coolers can in most cases be located in the main tunnel with the piping. Piping should be hung on pegs or brackets in a bank on the walls of the main tunnel, the smaller lines coming near the ceiling and the larger lines near the floor. Branch feeders to the engines should be taken off at right angles to the main lines, carried up to the ceiling and across the tunnel, thence up through the main floor to the engines. Wherever possible, pipes passing through the main floor slab from the conduit should be carried through sleeved holes slightly larger than the lines instead of through large square or rectangular openings which must be covered with floor plate. Tunnel and basement floors should be sloped to drain toward a sump from which drainage may be handled with a small motor-driven sump pump.

The conduit system just described is contingent upon the use of vertical engines in the plant, with exhaust and air-intake being carried overhead outside the building. Installation of horizontal engines would require some variation

in the plan outlined above; but, since nearly all modern engines of large horsepower are of the vertical type, this angle need not be discussed here.

Owing to the presence of hot-water lines and motor-driven units in the basement and tunnel, provision must be made for their ventilation, or the temperature of the air will at times become almost unbearable. One or more stacks with good wind-suction type ventilators of capacity sufficient to provide about fifteen air changes per hour should connect the basement and tunnel with the outer air. Another scheme which augments the action of stack and ventilator is to cut small tunnels connecting the engine flywheel pits with the adjacent basement room. The engine flywheels, being completely housed by sheet-iron guards, act as centrifugal air pumps and throw a constant blast of fresh air into the basement. Ordinary floor registers placed over these tunnels at points of entrance into the basement make it possible to cut off or regulate this cool-air supply as desired.

In considering the feasibility of constructing such an elaborate conduit system as outlined above certain questions or objections may come to mind. Paramount among these is the cost. Assuredly, the cost of all this deep conduit and basement would exceed that of a system of shallow conduits, but would this be offset to any extent by greater economies in station operation due to accessibility of lines, easier operation and repair of oil engines due to large unobstructed floor space, and the possibility of fewer accidents to workers due to elimination of dangerous conduit cover plates? Then comes the question as to whether or not the basement would constitute an additional fire hazard. Would it not act as a trap for heavy combustible gases accumulating in the engine room or generated from leaky oil lines in the conduit itself? And lastly, would there be any danger of flood waters filling the basement and injuring any auxiliary machinery located therein?

A comparison of the weight of these objections with that of the manifold advantages should unquestionably tip the scales of opinion in favor of large accessible conduits. In the first place the additional cost of such construction is really very small. Very little additional excavation is necessary, since almost the entire engine room area is excavated to a depth of six to ten feet for the main engine footings. The engine foundations will form a large part of the basement wall area, and to complete this wall area the outside wall foundation and part of the firewall foundation need only be carried to a depth slightly greater than would otherwise be necessary. The greatest expense, then, is the reinforcing steel required for the main floor slab, additional form lumber for supporting the slab while being poured and the labor involved. Considering the benefits derived, however, this additional cost is not prohibitive.

Since proper ventilation is a necessity for the comfort of workmen, the possibility of combustible gases collecting in the basement is practically automatically eliminated. Leaks in oil lines are not very dangerous because they can be so quickly detected and easily repaired on account of their accessibility. Basement and tunnel can be well lighted, and there is no reason why they should not be kept as clean as the main floor.

Obviously, it would not be good economy to construct a basement large enough to accommodate small auxiliary machinery in a station situated where there is danger of periodic floods rising above the engine-room floor level. However, even where this danger exists the advantages of the "head-room" tunnel for piping, heat exchangers and closed lub-oil tanks still maintain.

The general appearance of an engine-room floor unobstructed by small units and accessories, and whose expanse is unbroken by patches of floor plates invites to the mind ideas of neatness and cleanliness. With the incentive thus provided, experience shows that station operators will make every effort to keep up and improve the appearance of their plant. If we fill up a shallow conduit and floor it over smoothly with concrete, employes will keep the floor clean; but a floor whose homogeneity is broken by black, uneven steel plates offers no incentive to neatness—another black spot on the floor in the form of some spilled oil will not show up any worse than a patch of floor plate. And, where the floor is kept clean one usually finds clean, smooth-operating machinery. Dirty equipment obviously makes a dirty floor; but the reverse of this statement is also true, i. e., a dirty floor makes dirty equipment.

Thus we find that by doing away with small conduits in the floor and providing ample room beneath the main floor level for all piping and small engine accessories we eliminate hazards, promote more satisfaction among employes, and have less trouble keeping equipment in good running order.

Compressor side of station basement.

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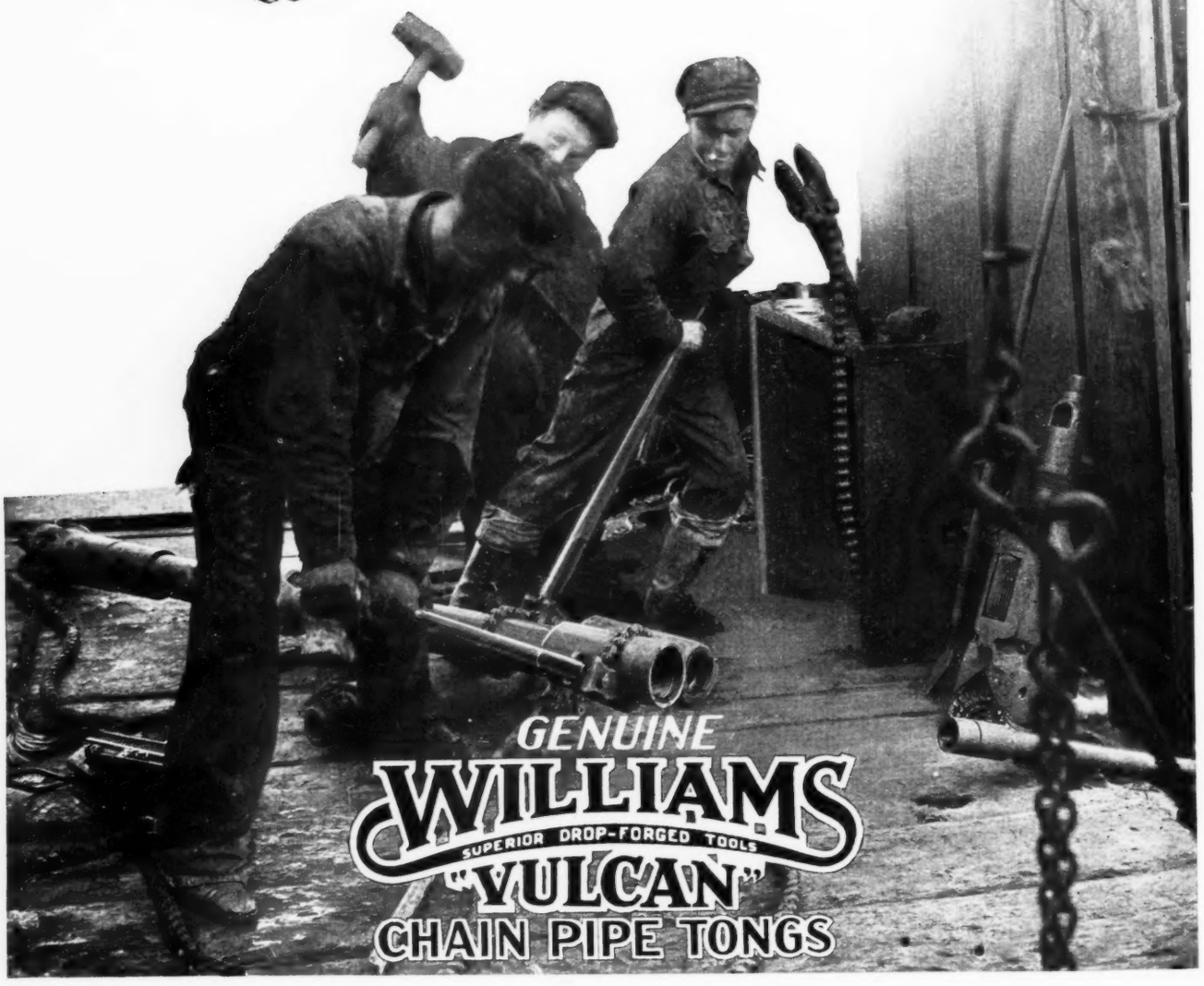


Factors Controlling *the* Effective Lubrication *of* Diesel Engine Power Cylinders

Article II

By ARTHUR M. TODE, M. E.
Technical Division, The Texas Company

Importance of Good Piston Seal and Oil Film

THE high pressure gases above the piston of a Diesel engine are only prevented from leaking between the piston and cylinder wall by properly fitted rings in conjunction with a suitable sealing medium in the form of a lubricating film. Although the metal surfaces of cylinders, pistons and rings are carefully finished and accurately fitted, leakage of gases cannot be prevented unless the small openings between the wall and rings are effectively sealed by a viscous fluid.

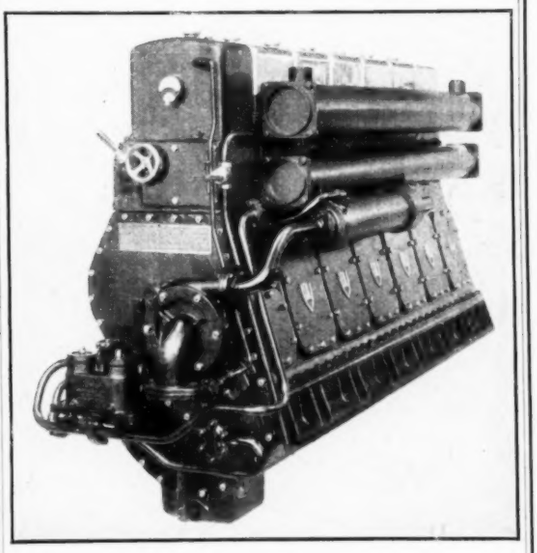
Metal surfaces rubbing one over the other will generate excessive heat and produce abrasion of the material unless the surfaces are separated and free motion permitted through the use of a suitable fluid medium. This results in high metallic friction being replaced by low fluid friction and provides an adequate lubricating film to seal the piston properly while minimizing destructive metallic friction.

The lubricating oil film must be maintained under two distinct conditions of operation, i. e., high temperature and high pressure. The higher the temperature of the products of combustion the hotter are the adjacent parts, and consequently the thinner the oil film separating the metal surfaces. The greater the gas pressure, the more difficult it is to maintain a lubricating film between the rubbing surfaces. The upper piston rings, especially, will be called on to bear the brunt of these operating conditions.

Effect of Cylinder Pressure on Oil Film

With pressures rapidly increasing during the compression stroke, until a maximum of about 500 pounds per square inch is reached in the cylinders of a Diesel engine, it is the duty of the oil film to reduce leakage of the compressed gases to a minimum. The gases will tend to escape past the split of each piston ring as well as past the clearance between each ring and its groove. This causes pressure to build up behind the rings. The highest pressure is, naturally, behind the uppermost ring and is nearly as great as that on the piston head itself; it decreases gradually behind each succeeding ring until it is practically negligible behind the lowest ring.

These pressures tend to force the rings, particularly those nearest the top of the piston, against the cylinder wall, producing a squeezing action which the lubricating oil film must support. The oil film is, therefore, dependent upon to support the pressure of the rings, while at the same time it must effectively seal them against blow-by during the compression and power strokes.



(I. P. Morris and De La Vergne, Inc.)

A high-speed, four-cycle De La Vergne Diesel engine, showing location of duplex oil pumps, filters, coolers and sump tank. In this system one pump takes the oil from the sump tank to the storage tank, while the other pump takes the oil from the storage tank and delivers it through the filters and coolers to the bearings of the engine.

Effect of Cylinder Size on Oil Film

The influence of heat and temperature on the lubricating oil film in Diesel engine cylinders is also dependent on the size of the cylinders. With two cylinders of different diameters, but equal mean effective pressures, the products of combustion will lose their heat less rapidly during the power strokes in the cylinder having the larger dimension.

Small bore cylinders are easily lubricated. Although the cylinder wall area increases only as the bore, so that the heat conditions might not at first be considered serious for large bores, they do become more so as the size increases. This is borne out both by increased lubrication and cooling difficulties. The amount of heat liberated increases as the square of the diameter and the greatly increased heat effect is probably due to radiant dissipation of heat. This has been shown experimentally to be a very important factor in heat loss from the burning charge to the walls.

Combined with the unavoidable greater thickness of cylinder liners in the larger engine, the temperature difference between the cooling water and the gases in the cylinder will tend to increase. Furthermore, the increased cylinder wall thickness tends to reduce the heat absorbed by the cooling water and, therefore, augments the temperature of the oil film. As the temperature of the oil film is greater with large cylinders than with small ones the former require the use of a somewhat higher viscosity oil for efficient lubrication.

Combined Effect of Temperature and Pressure

The high temperature of combustion in a Diesel cylinder occurs simultaneously with the high pressure. This combined action, especially under adverse conditions, will be very detrimental to the oil film which will tend to thin down; it will furthermore enhance loss of compression and excessive cylinder liner wear. This inevitably results in increased power and upkeep costs.

Under such conditions of high pressure and temperature the lubricant must be able to spread rapidly on cylinder walls and to

replenish its own lubricating film. It must have film strength even when exposed to high combustion temperatures as well as the pressures to which it is subjected through the piston rings, and it must maintain a complete piston seal effectively under all conditions. Cylinder liner wear is generally greatest at the combustion ends of the cylinders where maximum temperatures and pressures exist. The wear decreases along the cylinder walls in proportion to the lower temperatures and pressures encountered during the power stroke.

Oxidizing Influences and Their Control

Regardless of the base of crude oil from which lubricating oils are made, oxidation takes place after a certain temperature is reached. This is first noticed in the darkness of color, oxidation forming in oils undesirable molecules of asphaltines, the extreme of which is artificial asphalt, a black, sticky matter which has a very high coefficient of friction in comparison with that of the original oil. This oxidation takes place regardless of the care or methods used in refining these oils.

If the improper method is used for application of lubricating oils to the power cylinder, the oxidation of the oil is greatly increased, forming undesirable products in the new oil before it reaches the pistons. These undesirable products formed by oxidation increase friction, which results in a high cylinder liner and piston ring wear.

The necessary details to be considered in the control of oxidation of the oil are the arrangement of the lubricating oil piping, the lubricating oil injection tube in cylinders, the size of lubricating oil ports in the cylinder liner, and the design of the mechanical lubricator.

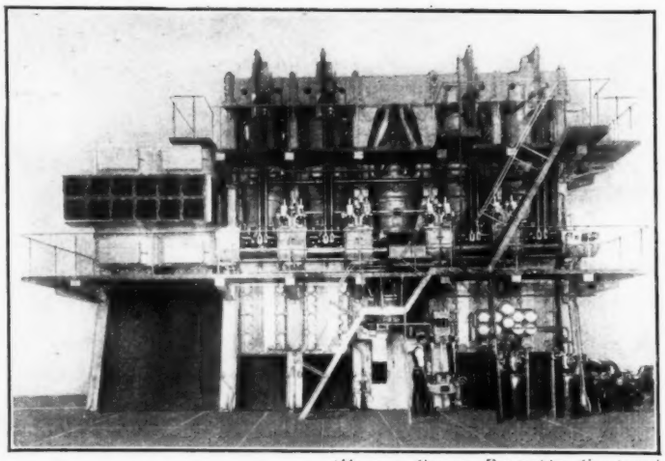
Points of Cylinder Oil Delivery

The number of points at which the lubricant should be applied to the piston will depend on the type and size of the engine. Two to four oil holes equidistantly located in the cylinder wall will generally suffice, although this will, of course, depend on the bore of the cylinder. They are usually located between the first two piston rings when the piston is at its lowest point, although in some engines the oil supply points are found above such positions. One point of delivery is not considered as dependable due to the possibility of the opposite side of the cylinder being underlubricated. In certain cases this can be obviated somewhat by cutting an internal groove in the cylinder wall at the point or points of injection for more even distribution of the oil.

Practical considerations of design may limit the number of points where the lubricant is fed to the cylinder, but they should not be too far apart otherwise an excessive quantity must be introduced in order to furnish a sufficient lubricating film midway between the points of introduction. In the two-cycle engine, care is taken that none of these oil holes are located in line with the exhaust ports, for otherwise the exhaust gases would tend to carry off a certain amount of lubricant which would be wasted.

It is now more or less standard practice to use a separate pump plunger of the mechanical lubricator for each point of oil introduction. This is desirable to insure positive lubrication and to obviate the possibility of one lead receiving more or all the oil due to difference in resistance at the end of the individual leads, which might cause cylinder scoring or even piston seizure.

The exact location of the oil feed to the cylinders represents the manufacturer's idea of how lubrication is best accomplished. Some designers have even gone so far as to synchronize the time of lubricating oil delivery with the lowest position of the piston. The objective in all cases, of course, is the proper distribution of the oil over the whole cylinder wall surface subjected to rubbing contact, together with the attainment of the lowest permissible oil consumption. The comparatively large amount of wear which normally takes place on cylinder liners perhaps may be due to the fact that satisfactory lubrication of cylinder interiors is frequently difficult to attain.



(Hooven, Owens, Rentschler Company)

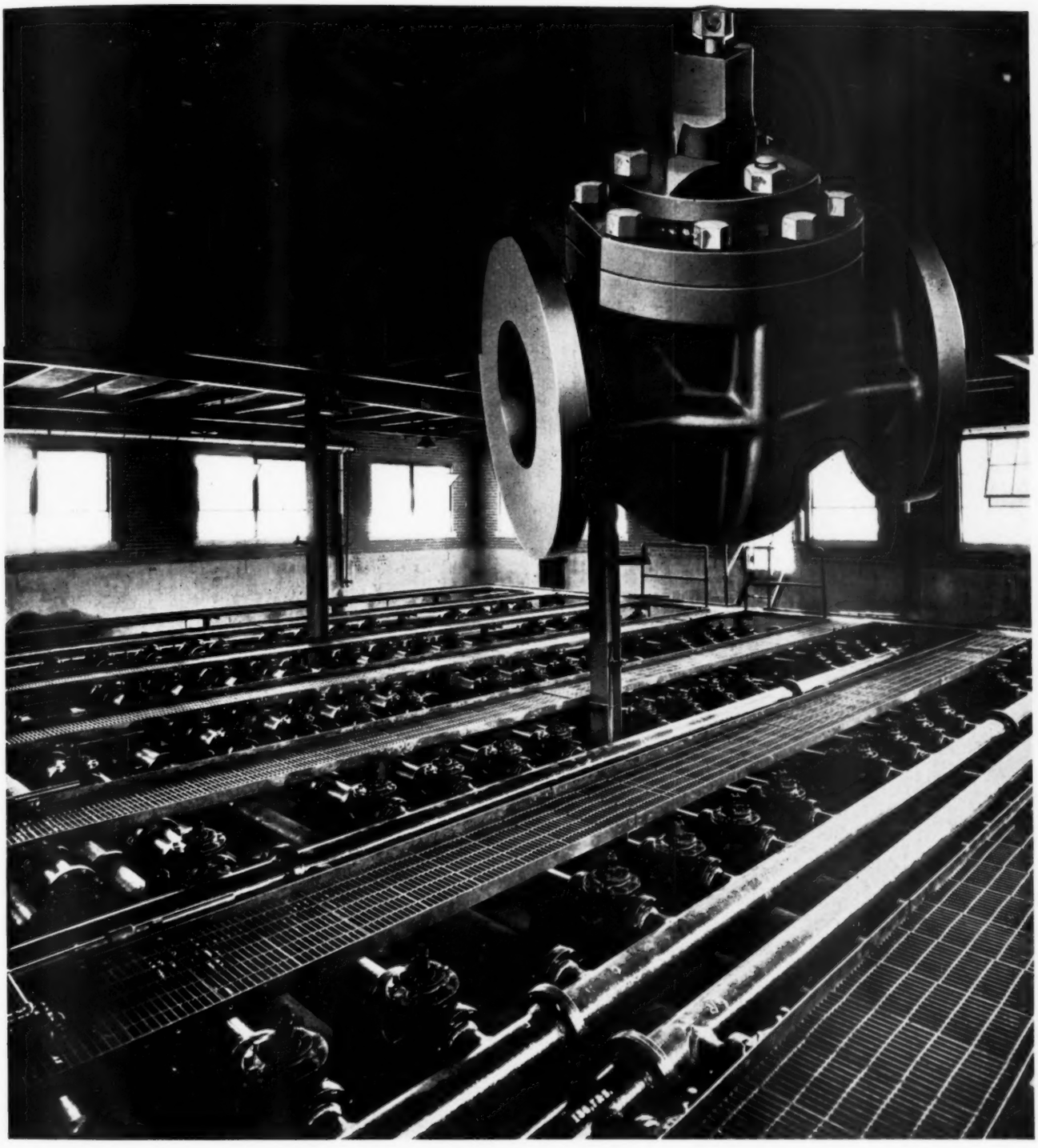
Side view of a 4000 B. H. P., 27½-in. by 47¼-in., two-cycle, air injection, marine type Hooven, Owens, Rentschler Diesel engine. Force feed lubrication is applied throughout and separate pump plungers are employed for each point of cylinder oil introduction.

Proper Quantity of Oil Feed Is Essential

Fewer subjects are more frequently discussed in relation to Diesel engine operation than that covering the amount of lubricating oil necessary for efficient cylinder lubrication. No general figure can be stated, as this is dependent upon such factors as the type and construction of the engine, grade and quality of the oil, the method of application, the number of oil feeds and the kind of lubricant employed. While certain figures based on a definite number of drops per minute could be quoted, dependent upon ideal operating conditions, it is still very desirable that a certain amount of experimentation be carried out for practically every oil will vary in its lubricating ability, according to its viscosity and manner of refinement.

Oil engine operators should always be guided by the recommendations of the manufacturers of each type of engine, and by their own close observation of the condition of the engine cylinder walls, so they can gradually reduce the amount of lubricating oil to the most economical degree. Where a mechanical force feed lubricator is used, capable of feeding oil in synchronism with the strokes of the pistons it is frequently possible to control the oil feed so accurately as to approximate the theoretical requirements of the engine for the particular oil in service.

While cylinder lubrication is often carried out separately, with engines of the enclosed crankcase splashed-oiled type, a certain amount of lubrication will be derived from the vaporous fog of lubricant which is present in the crankcase during operation. Naturally this should justify a certain amount of reduction in the oil feed to the cylinders themselves. The extent to which secondary cylinder lubri-



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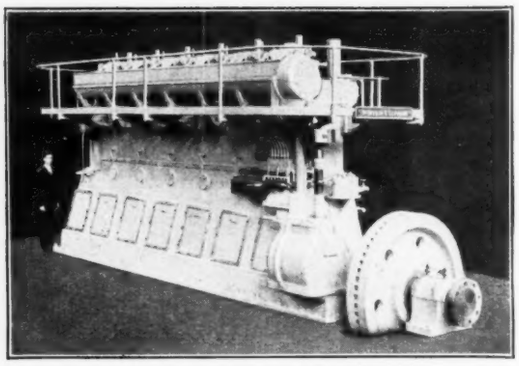
Factory - Oakland, Calif.

Canada - Peacock Bros., Ltd., Montreal, Toronto, Winnipeg, Vancouver. (Also Sydney, N. S.)
England - Audley Engineering Co., Ltd., Newport, Shropshire.
Buenos Aires, Argentine - General Electric, Soc. Anon., Victoria 618 Esq. Peru.



(McIntosh & Seymour Corporation)

A medium-speed, four-cycle McIntosh & Seymour Corporation Diesel engine employing oil-cooled pistons. A pressure lubrication system provides for the bearings, while a force-feed mechanical system furnishes the lubricant to the cylinders and air compressor.

cation of this nature is brought about, however, is not measurable with any accuracy; therefore, the amount to which cylinder lubrication could be reduced cannot be definitely stated. It must be remembered that wherever the crankcase serves also as an air compressor, lubrication of the two-stroke cycle, splash-oiled engine has a potential tendency of requiring more oil in general than a four-cycle engine. Essentially this is due to the possibility of oil being blown out while in vaporous form during the scavenging period.

Experience has also shown that lubrication should be positive and uniform, otherwise rings will be worn and may even become stuck, with an appreciable loss in compression. The wristpin, for example, will also be affected. This part on certain engines will be subjected to relatively high temperatures, with but little opportunity for reducing this heat, unless it is cooled mechanically.

More attention should be paid to the condition of the oil film than to the quantity. The pulling of pistons and the finding of the cylinder walls well covered with an oil film is often misleading, because the oil may contain oxidized products that are detrimental to lubrication.

The Effect of Using Heavy Fuels

When heavy fuels are burned the rate of lubrication to the cylinders must be increased. While figures regarding the per cent increase above that specified for normal Diesel fuels cannot be definitely stated, because of the many factors involved, yet they can be expected to vary from 10 to 30 per cent and higher above the regular consumption. Even with satisfactory combustion conditions trouble may arise with contamination of the piston lubricant by unburnt fuel. When very bad contamination occurs, some temporary improvement may be effected by syringing the piston and liner with kerosene, afterwards feeding with a copious supply of lubricating oil to preserve the oil film.

Such contamination may be avoided to some extent by giving immediate attention to the fuel valve as soon as any indication of dribbling, or faulty atomization becomes evident. Where a piston is in a very dirty condition the addition of about 20 per cent kerosene to the lubricating oil in the mechanical lubricator will assist materially in keeping the piston clean and avoiding piston grunting. Under such conditions the rate of oil fed to the cylinders must be increased to compensate for the reduced lubricating property of the lubricant.

Over-Lubrication Must Be Avoided

It cannot be too strongly stressed that excessive lubrication of cylinders is detrimental in the long run to satisfactory Diesel operation. In small, high-speed engines where cylinders are lubricated by oil thrown from the bearing system, operators have no control over the rate of feed. In such cases baffle plates and scraper rings are depended upon to prevent excessive quantities of the lubricant reaching the walls and over-lubricating them.

Even with the most suitable oil over-lubrication leads to abnormal carbonaceous deposits in the cylinder, which may clog valves or ports. As has been pointed out, this effect is more pronounced in the case of the four-cycle than the two-cycle engine, due to excessive oil being blown out through the exhaust ports of the latter type.

Damaging Effect of Carbon Deposits

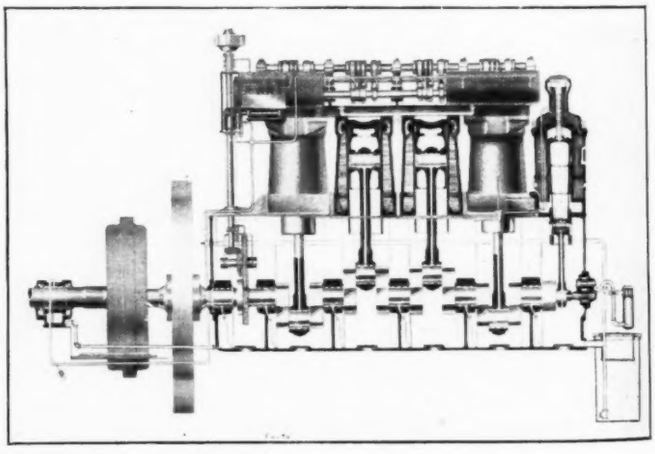
Carbon deposits in the cylinders are only too frequently blamed on the lubricating oil, but in most cases care on the part of the engine operator would eliminate carbon trouble. Carbon exists in two forms.

1. Fine, free carbon suspended in the fuel and lubricating oils.
2. Chemical combinations in the form of hydrocarbons which go to make up the oil.

With fuel so regulated as to give a clear exhaust and by using only sufficient oil to lubricate the cylinder, carbon troubles will be reduced to the minimum. An over-lubricated cylinder will always cause trouble from carbon.

Such deposits eventually may restrict the area of the exhaust, thus preventing proper scavenging. This means that part of the residual combustion products will occupy some of the volume which properly should be occupied by fresh air. This will, obviously, lower the volumetric efficiency. The result will be that cylinder temperatures may rise, lubrication will be impaired, wear will be increased, seizing of the pistons and loss of power may occur and there will, of course, be excessive lubricating oil consumption.

Excessive deposits in piston ring grooves are a common cause for improper functioning of the rings. Such deposits result in blow-by of the gases, the destruction of the oil film, and excessive wear of both rings and cylinder liners. Deposits collecting on valve seats and spindles are directly responsible for leakage and loss of power.



(Worthington Pump & Machinery Corporation)

Longitudinal and sectional view of Worthington four-cycle air injection Diesel engine, showing details of lubrication system. One grade of lubricant is used throughout for the bearings, power cylinders, and air compressor. Bearings and gears are pressure-lubricated by a geared pump, driven from the main crank shaft.

Left: Two 10,000-barrel storage tanks and one 55,000-barrel storage tank with Wiggins Floating Roofs; also a 20,000-barrel Hortonspheroid for 15 pounds pressure at a gasoline pipe line station. Below: 55,000-gallon elevated water tank at a compressor station near Goodrich, Texas.

HORTON PRODUCTS for Oil Pipe Lines

CRUDE oil pipe lines have used Wiggins Floating Roofs extensively for years. Now companies building gasoline pipe lines are profiting by their experience with crude lines, and are equipping the gasoline station and storage tanks 100 per cent with Wiggins Roofs. Wiggins Pontoon Roofs have several new features. They are non-sinkable. The pontoons provide insulation for the seal and reduce the temperature of the liquid.

Pipe line stations use Horton elevated tanks to supply water for compressor cooling and general service. They are available in standard sizes, suitable for pipe line stations.

We also supply standard storage tanks in all capacities, Hortonspheres and Hortonspheroids for pressure storage of volatile liquids and refinery equipment of all kinds. Our nearest office will gladly furnish information and prices on any of these products.

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New York	3173 Hudson Terminal Bldg.	Philadelphia	2635 "1616" Walnut St. Bldg.
Cleveland	2251 Midland Bank Bldg.	Boston	1535 Consolidated Gas Bldg.
Dallas	1271 Burt Bldg.	San Francisco	1064 Rialto Bldg.
Birmingham	1570 Fiftieth St., N.	Seattle	4345 Smith Tower
Tulsa	2434 Exchange Bank Bldg.	Los Angeles	1346 Pacific Mutual Bldg.
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INSOLUBLE Gasoline Lubricant

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Also insoluble in water.

Not affected by sulphuric acid, caustic or doctor's solution present in gasoline during refining process.

"John Crane" Insoluble Gasoline Lubricant provides positive lubrication for any style or make of packing. Insures cool running pump shafts, rods and plungers. Reduces fire hazards. Eliminates excessive wear. Prevents discoloration of gasoline.

Greatly improves efficiency of operation when used regularly in lubricating bearings, valve stems and all moving parts in contact with gasolines and distillates. A trial will convince you.

Oil field stocks at all National Supply Company Warehouses.

Apply to each ring of packing before installation.

"John Crane" packings we recommend for gasoline service are thoroughly lubricated with this lubricant.

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Philadelphia—108 Walnut Houston—2103 Woodhead
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Our catalog will give you complete information concerning this equipment.

THE CHAPLIN-FULTON MFG. CO.
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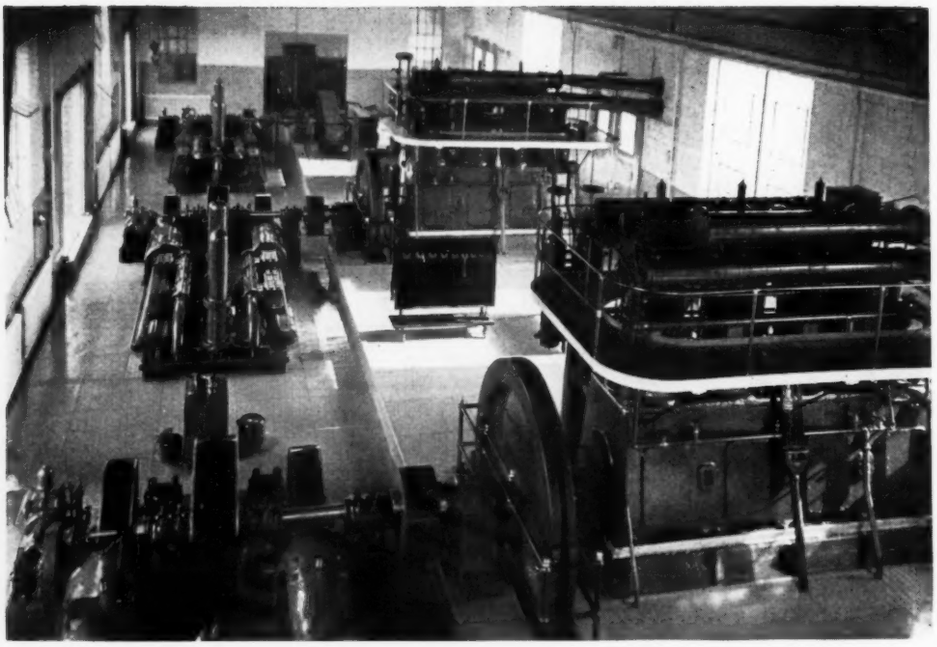
Tool Racks *for* Pump Stations



In the center of this picture is shown a portable tool rack for general use.

TRIM appearances in a pipe line station usually bespeak an economically operated pumping plant. Where this care is carried on to the orderly keeping of small tools station costs are further lowered and the number of minor accidents caused by faulty tools is reduced.

With tools racked in orderly arrangement station crew members are further induced to keep them in good condition and clean. Under such conditions they are safer to handle because with tools free of grime and oil there is less likelihood of hands slipping off or the tool slipping and striking someone.

Most pipe line companies have installed or are installing wallboard racks not only to help prevent the loss of tools but to keep them in a good state of repair and have them readily available. Some machinist long ago remarked that tools in a pipe line station could always be found when not wanted. By having them conveniently racked a great many of the station engineers have found a solution to most of their troubles arising from lost or battered small tools.

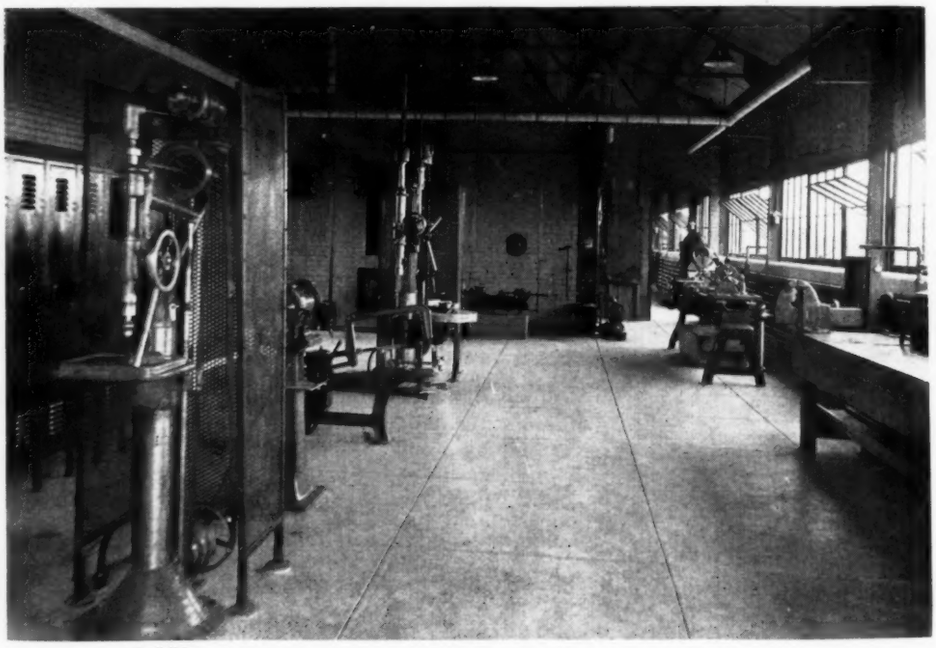
The most common type of tool rack is a large tool board that is fastened to the wall in most instances. These are usually painted a dark color with an outline of the tool to be racked painted with light paint over the tool's position on the board. A glance at the tool board will tell any of the station employes which tools are being used or are away from the rack for any other reason.

Engine room tools are usually racked on one or two boards fastened to the fire wall at the most convenient location. Ordinarily one rack will suffice for the pump room side of the station. Some companies rack the tools in cabinets but use most of the ideas incorporated in a wallboard rack.

By having an individual place on the rack for such small tools as screw drivers, bearing scrapers, etc., it has been found that the loss from damaged and nicked tools has been materially reduced. When kept in a box or on a work bench they are frequently damaged or chipped when struck by carelessly tossed heavier tools.

With the tools hanging on a rack in plain view, crew members take greater care of them. Seldom are they placed on the rack dirty because to do so would possibly spot the light painted outline, adding more work in keeping the station neat. Should a dirty tool be racked it would be quickly spotted by some member of the crew.

Another point in favor of racking the tools is that it has a tendency to reduce the annual cost of replacing lost tools. Some of this loss is, of course, traceable to petty pilfering, especially at some stations whose locations draw a considerable number of local visitors. With the tools on a board and where their absence would be noted immediately visitors are not so likely to remove them. When a new tour comes on duty they may make a quick check and locate any missing tool. And one of the final arguments for racking tools is that they are readily available when needed.



General view of machine shop.

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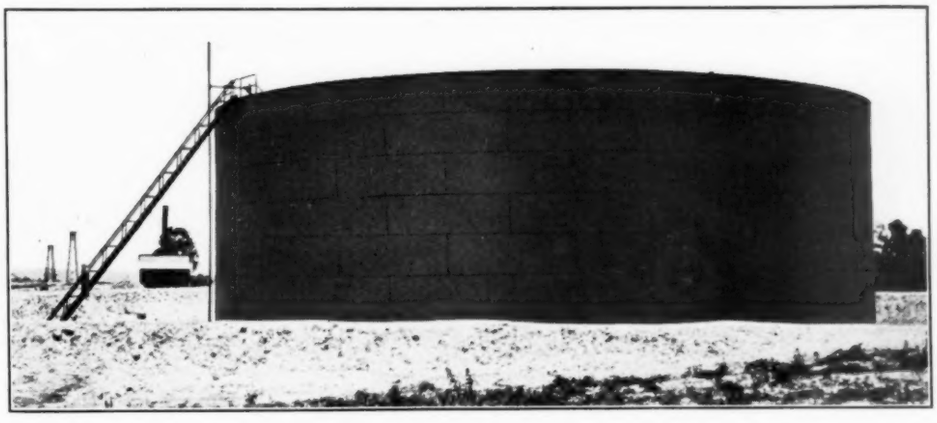

This Tank Saved $70,000 — Erected Only 6 Months Ago!

The 80,000 barrels of dollar oil stored in the above "Pittsburgh-Des Moines" tank was NOT sacrificed at ten or fifteen cents during the disrupted oil market of the past summer. Erected in the spring of 1931, it has already repaid its wise owners many times for its cost.

There are many other "Pittsburgh-Des Moines" storage units today saving Texas and Oklahoma oil producers from a costly and needless sacrifice of a valuable product.

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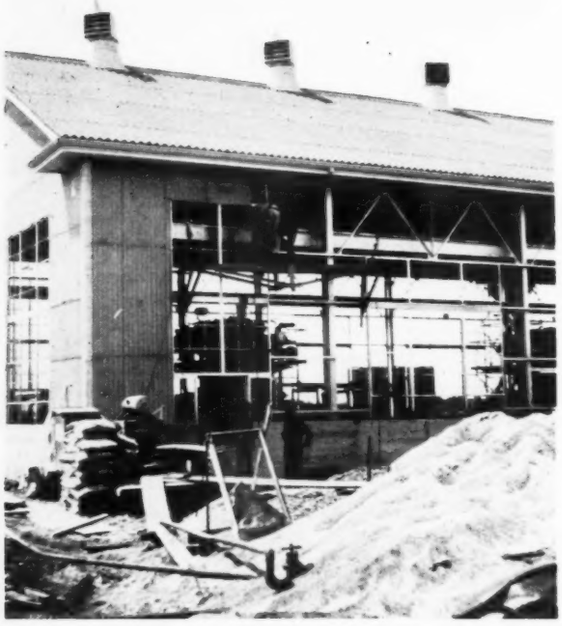


Corner view of pump station under construction, showing how the corrugated sheets are being placed on the walls.

UNTIL recent years pipe line pumping equipment ordinarily consisted of very large and heavy units and the trend was toward installation of even larger units, although there were no material changes in the design of either the main line reciprocating pumping units or the Diesel-operated motive power. The use of oil engines of 750 horsepower and pumps of 48,000 barrels daily capacity resulted in a higher operating efficiency than the units previously in use and, in addition, were a natural sequence to the installation of larger lines using improved pipe, permitting operation with higher pressures.

The recent introduction and favorable acceptance of high speed, light weight Diesel engines together with centrifugal pumps connected through step-up gears has tended to decrease, to a certain extent, the problem of handling exceptionally heavy machinery, but it has not reduced the problem of proper alignment, which is of greatest importance. Even though centrifugal pumps direct connected to high-speed electric motors are being increasingly used, there is still wide demand for oil-operated power for permanent main-line installations. Due to greater demands from machinery and the insistence that operations be on a more continuous basis, the problem of proper setting is more important than at any time in the past.

A few remarks on handling heavy machinery from cars to the station site and placing on foundations seem desirable, although presenting no unusual problem. It is not uncommon for flywheels and bedplates to approximate twenty to thirty tons each, and efficient as well as economical handling must be secured. A station site within close proximity to a railroad siding is desirable but not always available, which adds to this problem. Tractors and trailers are usually necessary in moving heavy equipment. A suitable truck equipped with a powerful winch and line is the erector's best friend. All of the heavier pieces are moved by jacks, chain hoists and winches by placing heavy timbers for a track and using pipe for rollers. The actual moving of heavy machinery must be undertaken with skill and precaution because of the danger involved, but it does not need the skill required of the erector.

While the machinery is being moved to the site, the foundations have been completed and are ready to receive the equipment. The foundation bolts should be thoroughly checked to see that all are in proper position and they should permit the machinery to be placed on the foundations with sufficient clearance for necessary shifting in making final alignment. Proper checking oftentimes saves jacking up a bedplate or some other heavy item, which is inexcusable if the mechanic has had proper training and experience. It is very good practice and a large saver of both time and money to unload the machinery direct from the truck or trailer to the foundation.

It is of utmost importance that alignment be started when the frames, bedplates and bearing sole plates have been placed in position. The engine and pump should be set and grouted at the same time, because to set each unit individually nearly always results in improper alignment. The setting of both engine and pump should be considered as one operation and must be so handled if proper results are to be achieved. It is necessary that the correct elevation for the pump and engine be computed, and they can both be leveled by using either leveling screws of steel shims or steel wedges placed close enough to prevent any sag.

There are several suitable methods for aligning machinery. The Mandrel is the easiest and quickest, but not always adaptable, and for that reason the tight wire and straight edge are more commonly known and just as accurate if properly used. By the tight wire method, a wire drawn through the center line of shaft and gears should be permanently established. All frames should be shifted into place by using a pin gauge or micrometer, and this can be done by taking one-half the diameter of the shaft minus one-half the diameter of the wire and trying the instrument between the wire and bearing surface, allowing very little for sag in wire. It is also necessary to use a steel scale or small straight edge across the face of the coupling rims for obtaining true alignment between the two couplings. After this has been completed, the pump shaft and engine shaft should be put in place, painting the shafts in all bearing spaces with Persian Blue and then rolling the shaft one-half way round. On lifting the shaft out of

Main-line pump station under construction, showing wall area utilized for lighting.

Pump Station Equipment

Manager, and A. C. WILKINSON, *Superintendent, Continental Pipe Line Co.*

bearings one will note where the blue has come in contact with the bearings. It is then necessary to make slight adjustments in frames or scraping high spots from bearings, provided almost perfect alignment has been secured. It is better to secure alignment through adjustment of frames, reserving the scraping operation for minute adjustments. This procedure should be continued until all portions of the bearings show an equal amount of blue throughout the shaft, making sure that all outboard bearings are equipped with sole plates and shims (unless they are of wedge type). The shafts are then left in place, the foundation bolts slightly drawn and the machinery is ready for grouting. The mixture should be an equal proportion of cement and screened sand. When this has been allowed to set for a sufficient length of time, all foundation bolts should be tightly drawn; it is then necessary to blue and raise the shaft again, scraping all bearings to fit perfectly.

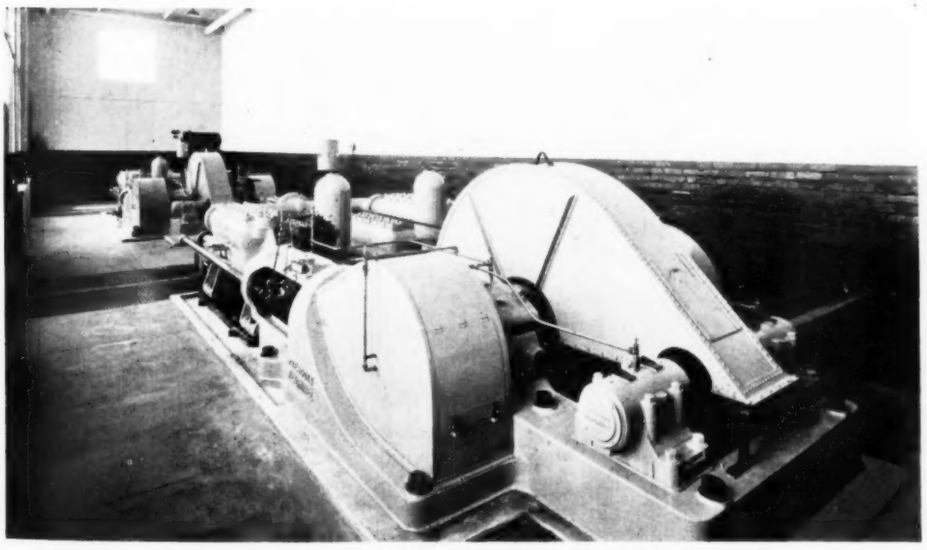
The shafts of vertical engines are usually set in place when shipped from the factory, and in this case it is only necessary to lift bearing caps and wash thoroughly so that one is sure there is no dirt or foreign particles left to score the shaft or bearings. It is necessary and important that the outboard bearing and stub shaft be absolutely in line with bedplate or crankshaft of the engine, for the crankshaft must be maintained in perfect alignment because, if it does not run true, bearing wear will be increased and resultant bending of the shaft may cause crystallization of the metal and consequent breakage. Inside micrometers or a pin gauge may be used in the following manner if the shaft is true: Place the pin gauge or micrometer between the lower ends of the webs while the crankshaft is on top center. The gauge should fit in the same place with the crank on bottom center. If loose in the former position, the shaft is high at the ends and low in the middle. If tight on top center, the reverse condition is indicated.

The primary essentials of successful bearing maintenance are alignment and lubrication, for the methods by which modern Diesel engines are constructed and the principle of design by which springing (deflections) are avoided practically insure that the journal of a crankshaft will get complete support over its entire length. Therefore, the mechanic is primarily concerned with alignment only while leveling the engine and before bolting up the shaft coupling. Final assembling of the engine is now begun and, if possible, the building frame and crane-ways should be installed so that they may be used in setting the machinery. Shop-made "A" frames or tripods are used to great advantage, saving much time and cost and also reducing accidents.

Small, high-speed equipment with large capacity is being used to good advantage, especially as original installations during the period of flush production. They serve as booster stations on main lines to provide for peak demands and also as auxiliary equipment in main-line stations where spare pumping equipment is required. Low initial investment and high salvage value are among its advantages. This type of equipment is usually mounted on a bedplate or steel skids by the manufacturer and the mechanic is inclined to be negligent in aligning it; however, it is more important that it be properly aligned than slow-speed engines, because it takes only a very short time to completely knock out a balancing disc, bearing or coupling. Small equipment deserves just as much care in setting as large machinery—its volume is handled at far greater speeds and is necessarily subjected to greater wear. The fact that high-speed centrifugal pumps and step-up gears (when used with Diesel power) are small and of light weight demands that they be aligned and leveled to the greatest degree of accuracy.

The engine, being the heavy unit, may be set in its proper position, bringing the step-up gears and centrifugal pump to their positions by the use of the tight wire, plumb bob and square. There is always one coupling between the engine and step-up gear, and it is of such design as to take care of surge and prevent quick action on the gears. There are two couplings between the gears and pump, with a bearing supporting the shafts between the couplings. If the shafts are not properly aligned, one cannot expect the gears or couplings to give complete satisfaction, as there will soon be excess bearing and gear wear and continuous heating, caused by unnecessary friction. Couplings are nearly always abused. If the mechanic will bear in mind the fact that the coupling is to connect the driver to the driven and not to provide a flexible connection because of presumed improper setting, there would be much less shaft and bearing failures.

The life of machinery depends largely on its installation and alignment. Therefore, much time, precaution and use of accurate instruments should be given proper consideration.



Pump room side of a main-line station.

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CHAIN TONGS
for their *Extra* Strength

IN ARMSTRONG BROS. Tongs there's a built-in quality, an *extra* strength that can be relied on in emergency, that insures a longer service. They come with standard or reversible jaws.

ARMSTRONG BROS. Reversible Jaw Tongs. "Two tools for the price of one."

Improved Designs

The bearing of the jaw sockets on the bar has been greatly increased. Forged in lugs serve as chain guides, protect the bar end and prevent chains from jamming.

Handles:
The handles are drop forged from high carbon steel and have *both* stiffness and spring.

Jaws:
Jaws are drop forged from a special steel, are treated, hardened and tested for toughness and lasting qualities.

Chains:
Attached to each flat link chain is a leaden seal, evidence that chains have been proof-tested to two-thirds catalog strength—1,200-lb. to 40,000-lb.

When buying tongs, look for this seal that bears the Arm-and-Hammer. It is the sign of proven strength.

Write today for Catalog P-10, which shows, describes and prices ARMSTRONG BROS. Better Pipe Tools, the most complete line of pipe tools made.

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CRANE COMPANY, 836 S. Michigan Ave., Chicago, is mailing out copies of four new circulars that are punched and ready to be inserted in the company's loose-leaf binders distributed some time ago. Bulletin No. 241 is about the No. 7 many purpose valves for severe service; No. 242A is on the inverted open float steam traps; No. 244 describes the automatic stop-check valves for safety, and No. 245 is descriptive of brass fittings for flared copper tubing.

FOSTER WHEELER CORPORATION has published a fine new handbook on petroleum refining equipment. It is printed on enamel gloss paper, has interesting reading material and pictures.

PAPICO NATURAL GAS ODORIZING SYSTEM is described in bulletin O-2 printed by the Pacific Pipe & Supply Company, Los Angeles. This bulletin contains flow diagram and operation charts of the system, its parts and prices.

ODH UNIT PUMPING POWERS, a new development of the Oil Well Supply Company and the Nuttall Works of the Westinghouse Electric and Manufacturing Company for inexpensive pumping at one-half to 30 strokes, are fully described in a new publication identified by the companies as Circular 1928.

A NEW BROCHURE, which details the Johns-Manville equipment and materials with specifications for pipe line protection, is being distributed to the trade by Johns-Manville of New York City.

CHAIN GRATE STOKERS is the subject of a new bulletin issued by The Babcock & Wilcox Company, New York City. This publication describes a line of chain grate stokers, which, the company states, are built with all the precision of fine machine tools. Full descriptions of various types with suitable photographs and drawings are included.

MERCO NORDSTROM VALVE CO., 343 Sansome St., San Francisco, has issued a 172-page catalog illustrating approximately 30 types of Nordstrom lubricated plug cock valves. The catalog lists various types of valves made in different metals for handling different liquids, semi-liquids and gases, both neutral and acid. The catalog also lists steam jacketed valves, remote control valves and types with multi-ports, both in low and high pressure.

THE PYLE-NATIONAL COMPANY, Chicago, Ill., has published bulletin 167, which describes new developments in lighting equipment.

A NEW FRENCH CATALOG has been issued by the Cleveland Pneumatic Tool Co., Cleveland, Ohio, through its export manager, W. J. Linn. The catalog is neatly arranged with clear type and is replete with illustrations representative of hundreds of products of the Cleveland Pneumatic company and its associated concern, the Cleveland Rock Drill Co.

New Dardelet Licensee

THE Rockford Screw Products Company at Rockford, Ill., has been licensed by the Dardelet Threadlock Corporation to manufacture and sell bolts, nuts, and screws threaded with the Dardelet self-locking thread.

Manufacturing and selling licenses for the Dardelet thread have also recently been granted to Wm. Gaskell & Son, Brooklyn, N. Y.; to the Harrison Bolt & Nut Company, Harrison, N. J., and to the Standard Pressed Steel Company, Jenkintown, Pa.

Bridgeport Opens New Stores

A SECOND branch of the Bridgeport Machine Company is being established to serve the East Texas field. This branch is located at Camps, Texas. The building has already been erected, and the stock is being shipped in at the present time. The branch will be under the jurisdiction of Fred Parks, who is also manager of the Kilgore Bridgeport Store.

Bridgeport is also changing their location at McPherson, and by November 1 will have an uptown store, located directly across from the McCort Hotel. The company has also leased a pipe and material yard on the Rock Island Railroad right of way. This store is under the jurisdiction of Manager Fred McConnell.

Bridgeport has also opened a branch at El Dorado, Arkansas, specializing on pumping equipment. This store is being supervised by Mr. A. C. Bramer. Mr. Bramer is the patentee of the Moroil Shot Packed Pump, which is being sold through the Bridgeport sales organization.

Maintenance Engineering Represents Mason Regulator Company

MAINTENANCE ENGINEERING CORPORATION, 1400-2 Conti Street, Houston, Texas, announces that it has recently made arrangements to represent the Mason Regulator Company of Boston, Mass., in this territory, which concern is now associated with Neilan Company, Ltd., of Los Angeles, California, whom the Maintenance Engineering Corporation has been representing for the past several years.

Vogt Aeration Unit

THE new equipment item in the September issue of The Petroleum Engineer about the Vogt Aeration Unit stated it was a product of Henry Vogt Machine Company, whereas it should have read a product of Vogt Brothers Mfg. Co., of Louisville, Ky. This article appeared on page 104.

Statement of the Ownership, Management, Etc., of THE PETROLEUM ENGINEER October 1, 1931

(This statement is published in compliance with the Act of August 24, 1912.)

Published monthly at Tulsa, Okla.
Publisher: The Petroleum Engineer Publishing Co., Tulsa, Okla.
General Manager: Clarence Morris, Tulsa, Okla.
Editor: J. L. Dwyer, Tulsa, Okla.
Stockholders holding 1 per cent or more of total amount of stock: Warren L. Baker, C. R. Barrett, W. T. Bryan, T. J. Crowley, James H. Dameron, J. L. Dwyer, W. L. Love, Clarence Morris, K. C. Sclater, F. R. Staley, all of Tulsa, Okla.
Known bondholders, mortgagees and other security holders holding 1 per cent or more of the total amount of bonds, mortgages or other securities: None.

W. T. BRYAN,
Secretary-Treasurer.

Sworn to and subscribed before me this 7th day of October, 1931.

LILLIAN HADDOCK,
Notary Public.

My commission expires December 25, 1934.

COOLING WATER TREATMENT

Cooling water is often a source of trouble through its scale deposits and corrosive tendencies, reducing efficiency and causing replacements in internal combustion engines, compressors and condensing equipment.

Correction of these tendencies can be effected at moderate cost and without installing elaborate equipment. The Dearborn Laboratories are especially equipped to render this service.

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If water lines are not completely closed, scale can be removed. Dearborn Special Formula No. 134 is reliable, rapid and inexpensive in cleaning scale from water lines and in addition, all types of equipment where a quick periodic clean-up is advisable: heaters, cooling coils, engine heads and jackets, pumps, evaporators, meters, pasteurizers and boilers.

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Record Number *of* Fire Bends on Iowa Pipe Line

A completed side bend.

THE recent completion of the Continental Construction Corp.'s 175,000,000-foot capacity gas line from the Texas Panhandle to Chicago, Ill., marked the finish of one of the most difficult line construction jobs in the country. Laying the 1,000-mile, 24-inch, combination welded and coupled artery subjected materials to a severe test and called for maximum skill on the part of the builders. An example of this may be found in Iowa, where Henry L. Lemons, Tulsa contractor, made 2,140 fire bends in 143 section miles with the National Tube 24-inch seamless used in the building of that section.

The sleeve type coupling was relied upon to take care of a two-degree bend, but beyond that fire bends were made. In order that this unusual bending could be accomplished with the least delay and maximum success, special crews, with years of experience, were placed in charge of the work of bending the large-diameter seamless pipe. After a few expected failures while the crews were familiarizing themselves with the work, bending progressed speedily.

Heating the pipe was done with pressure burners inside of a shield which had a tendency to wrap the flames around the outside of the pipe. After the metal had been heated a slow bend was started. This was done either with a tractor equipped with a slow pulling winch or with a block and fall rigging.

By having a tractor equipped with a winch suited for the work and an operator expert in handling the winch, faster time could be made because of the time saved in rigging and moving equipment. When such a tractor and operator were not available, the crews used a block and fall, which equipment was also used on the more difficult bends.

Usual equipment for the work consisted of a portable air compressor, fuel tank, burners, shield, winch lines and bending block. Frequently the crews carried a 40-foot length of pipe with them which was used as an anchor for the bending. The bending block, saddle-shaped at both ends, was set at one end between the 40-foot length and the 60- to 120-foot section to be bent. The two ends of pipe were lashed together and the pulling lines for either the tractor winch or block and fall were attached to the other ends of the pipe.

A portable compressor was used to build up pressure in the fuel tank containing kerosene. Care was taken to set the shield no closer than three feet to a weld and the torches were set inside the shield. Shields were made of sheet iron and designed to fit half way around the pipe.

About ten minutes was required to heat the pipe sufficiently before a tension was placed on it. The degree of success of the bend depended upon the judgment of the foreman watching the heat of the metal and directing the amount of tension placed on the pipe. When the inside of the pipe at the point of fire turned cherry red the bend was started. A slow pull was made at intervals, and during the time lag between pulls the metal adjusted itself to the expansion on one side and contraction on the other. With careful handling, successful bends were turned out time after time and required anywhere from 40 minutes to an hour.

Painting two completed bends.

Lufkin A. P. I. Meeting Big Success

W. C. Trout, president Lufkin Foundry & Machine Co., who was host to the Southwest District, A. P. I.

THE recently held Southern District fall meeting of the A. P. I. Division of Production at Lufkin, Texas, has been termed by many of those present as one of the most interesting and successful gatherings that the Institute has sponsored. More than 160 persons registered for the meeting.

Because of the interest in the East Texas oil field, located a short distance to the north, and which was discussed in many of the papers, the business sessions were widely attended and brought forth some very interesting discussions. Practices in both drilling and production were discussed and several suggestions were introduced that may result in better operating conditions for the field.

The first paper delivered on East Texas was that of C. W. Alcorn, Shell Petroleum Corporation. Mr. Alcorn discussed the "Correct and Incorrect Drilling Practices in East Texas." Blaine Johnston, vice-president of the Simms Oil Company, followed with a talk on the "Correct and Incorrect Producing Practices in East Texas." Under this topic particular attention was given to Christmas tree hook-ups, pumping equipment, treatment for paraffin, tank battery hook-ups and other producing methods and equipment.

Because of the frequent fires in the area a part of the meeting was given to fire prevention. M. L. Brown, Sun Oil Company, described situations which may cause fires and how the fires may be prevented in his paper entitled "Fire Prevention and Protection in East Texas." E. Stanley Durward, Shell Petroleum Corporation, completed the fire discussion with an illustrated description of the method used in extinguishing the Bell and Graddy fire in East Texas. This well was tunneled and the casing string tapped.

The success of the meeting is due in no small way to the co-operation of the Lufkin Chamber of Commerce and other civic organizations. Fine entertainment was provided for the members and many other courtesies were extended. Before the convention had terminated a vote of appreciation was given to the organizations and business firms that helped in many different ways.

The Lufkin Foundry & Machine Company was especially active in seeing that guests had ways and means of getting to their destinations. The company, with W. C. Trout, president, acting as host, also gave a Dutch luncheon at its large foundry and oil field equipment manufacturing plant. Members were later taken on a tour of inspection through the plant.

open the valves!

WHEN orders are issued to "open the valves," huge gas-driven compressors totaling nearly 75,000 horsepower will deliver natural gas into Chicago at 800 lbs. pressure that has been pumped all the way from Texas. These mighty engines will depend on COOK'S Graphitic Iron Power and Compressor Piston Rings for the vital function of maintaining the pressures. There are many reasons why COOK'S Piston Rings are selected by the prominent operators of Diesels, Gas Engines and Compressors. These facts are contained in a brochure, copy of which will be sent to interested parties on request.

C. Lee Cook Manufacturing Company, Incorporated, Louisville, Ky. Agents and Distributors New York, Chicago, Tulsa, Los Angeles and San Francisco.

"Sealing Pressures Since 1888"

COOK'S GRAPHITIC IRON Piston Rings

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The importance of the refinements introduced by the Pomona Pump to water development have been so far-reaching that they mark a new epoch in pumping. Greater economy, longer life, smoother operation and water lubrication have each been major turning points which have made important water pumping history.

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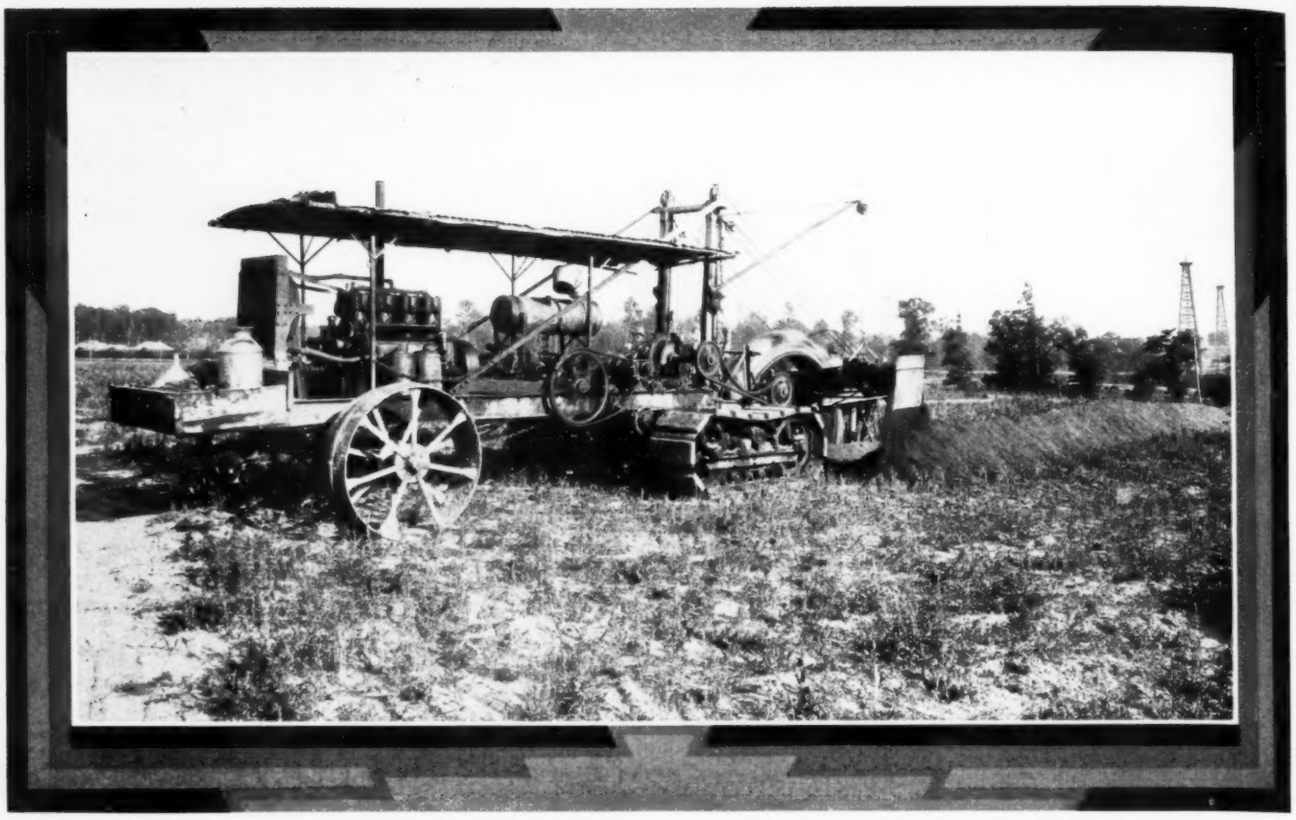
WATER LUBRICATED

TURBINE PUMPS



Probably 95% of all major American cross-country pipe lines are laid in Buckeye-cut trenches.

This record and the fact that most Buckeye owners standardize on them exclusively, often employing them in great numbers, prove conclusively that Buckeye Pipe Liners give "superior performance in oil and gas field requirements."

The complete line of Buckeyes provides a suitable size ditcher for every pipe line trenching need. Each model, large or small, is built directly to the specifications of the world's leading pipe line engineers and contractors. All embody the dependable power, practical speed, up-to-date operating conveniences, and economical service that have characterized Buckeyes for nearly 40 years.

Our Catalog, "BUCKEYE—The Pipe Liner", contains interesting specification and construction details.

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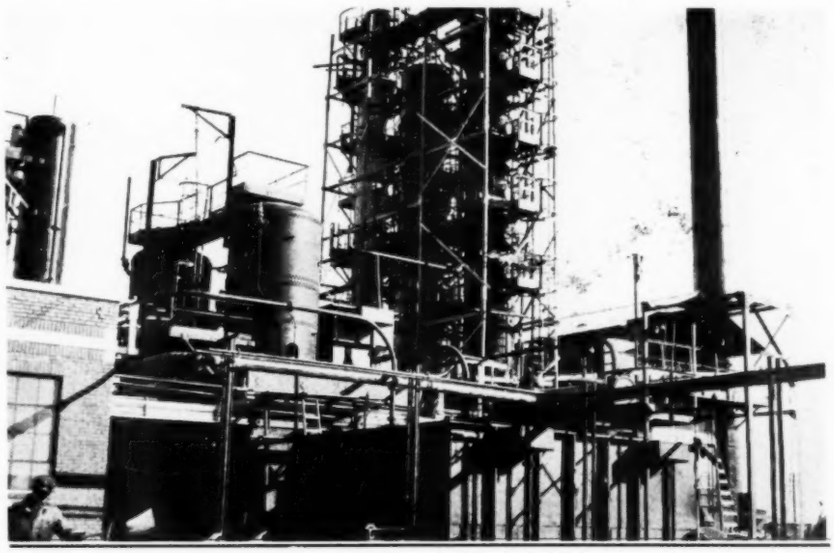
The Nature *of* Catalytic Actions

By
J. D. HASEMAN, *Consulting Chemist*

Introduction

CATALYSIS and adsorption are terms which have been applied to certain weird chemical and physical phenomena which could not be explained by simple chemical and physical processes. Catalysis was a process in which catalysts were supposed to initiate or speed up chemical reactions, but the catalysts did not directly enter into the reactions. Adsorption was in most cases supposed to be a process or phenomenon depending on surface tension, i. e., on the difference in density or concentration of a liquid in films adjacent to bounding medium and density or concentration of the mass of the liquid in which suspensoid particles attract ions of opposite electrical charge and hold them condensed at the surface of contact.



Distillation Unit at Continental Denver Refinery.

Some writers explained the decolorizing of oils by fullers earth as selective adsorption. Others considered fullers earth as a catalyst, especially when used to dewater certain pine oils to make solvenol. Hence adsorption and catalysis have been more or less intimately associated.

The purpose of this paper is not to compile and discuss the vast literature on catalysis and adsorption but to present briefly some well-known facts and certain new data and views on catalysis and adsorption.

This data indicates that most if not all cases of adsorption and catalysis within the range of vital temperatures and pressures are due to energy emitions of the catalysts and adsorbers which produce different kinds of active hydrogen.

Types of Catalysts

There are many catalysts which operate only within the range of vital conditions or between the boiling and freezing point of water. To this class belong enzymes, vitamines, etc. These catalysts require the presence of moisture in order to be effective. Fullers earth, activated clays, and activated carbons are also more or less efficient under the same conditions.

There are several other catalysts which operate at relatively higher temperatures and pressures. The bulk of these catalysts either require hydrogen, or moisture, or materials from which active hydrogen can be made by heat and pressure in the presence of the catalysts.

The catalysts which operate under vital conditions all exhibit a true relative acidity by freeing active hydrogen. These catalysts are invariably energized or activated either naturally or artificially.

The most of the catalysts that operate above the range of vital temperatures and pressures produce active hydrogen by the aid of high temperature and pressure. Some of these catalysts are not apparently energized at ordinary temperatures and pressures, but they operate more efficiently when in a near pectoid state. They also are more effective if they act as both a base and acid.

Both types of catalysts can be poisoned or rendered inert when the catalyzed products either prevent the formation of active hydrogen or the catalyzed products produce a reversible reaction. All activated or energized catalysts. upon continued reuse, become inert. Their reactivation is more complicated than the removal of their catalyzed products.

There are also two types of adsorbers. One like carbon is activated and exhibits a relative acidity, and the other like platinum which produces active hydrogen when hydrogen gas passes through it. Most adsorbers also act as a base and an acid and are often effective catalysts.

Methods of Energizing Catalysts

1. Nature activates such substances as enzymes by means of ancestral energized matter inherited from the germ cells and sunlight. The ancestral matter was possibly originally energized by heat, steam and sunlight.

2. Nature activates such substances as fullers earth by means of sulphuric acid, carbon dioxide, azo-silico-humic acid and colloidal silica.

3. Such clays as bentonite, hallocyte, indianite, etc., can be activated by a proper acid treatment. Each clay must be treated exactly right in order to get a highly efficient product which exhibits a much greater relative acidity than fullers earth.

4. Sodium silicate can be properly treated with acid to yield an activated product.

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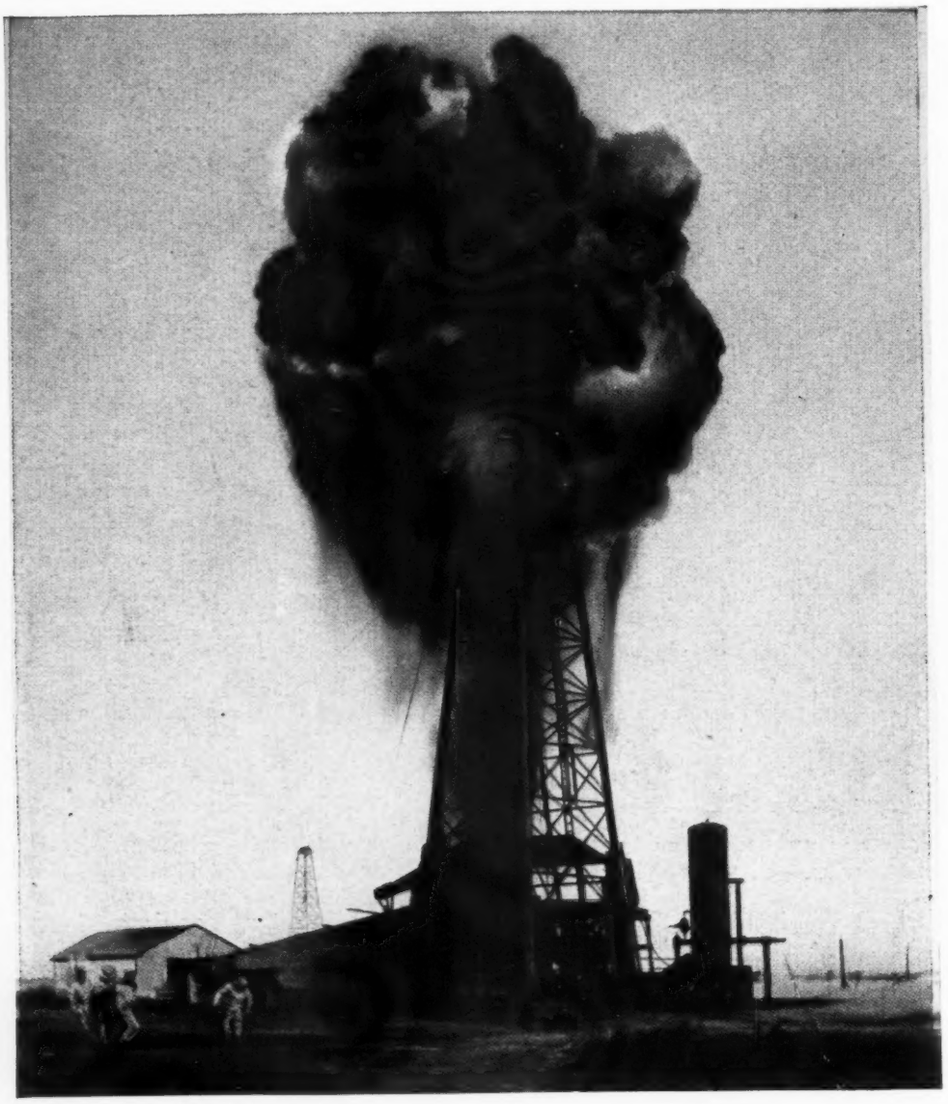


Photo No. 1--Oil Well Fire
Enlargement 13" x 16½"

FROM among thousands of available subjects we have chosen the three photographs shown on these two pages as the most striking ever taken in the oil industry. Each has been used as a front cover of *The Petroleum Engineer*, the Ice Covered Derrick and Oil Well Fire later being enlarged and complimentary reproductions sent to those readers who signified their desire for them by returning a coupon from an advertisement in the magazine. After the supply of reproductions had been exhausted, so very many requests continued to come in that it was decided to make a second printing of these two subjects and, in addition, enlarge a third extremely popular cover, Night Drilling Scene, any or all to be given with our compliments to each paid subscriber to *The Petroleum Engineer*. Those who have previously received the Oil Well Fire and Ice Covered Derrick will most certainly want the Night Drilling Scene to complete the set.

Any paid subscriber to *The Petroleum Engineer* may take advantage of this offer by clipping the coupon at the bottom of the opposite page and mailing it to us promptly.

KEY TO PHOTOGRAPHS

Photograph No. 1—Oil Well Fire. This famous well fire picture was used as the May, 1930, front cover of The Petroleum Engineer. The well, Skelly-Amerada University No. 1-A in Ector County, Texas, was being shot and a photographer, anticipating a gusher, had his camera trained on the derrick. Rocks thrown from the well came in contact with the steel crown block creating a spark which ignited the flow of oil and gas, at which instant the picture was snapped.

Photograph No. 2—Night Drilling Scene. Shows the Wirt Franklin Petroleum Corporation's No. 1 Shanahan drilling well in the Oklahoma City field. This picture proved to be one of The Petroleum Engineer's most popular covers.

Photograph No. 3—Ice Covered Derrick. An impressive scene showing, encased in tons of ice, the derrick of Eagle Butte Oil Co., Ltd.'s, No. 1 well in the Cypress Hills of Southern Alberta, Canada. While this well was being drilled water was encountered which, as it jetted from the hole during cold weather, froze in fantastic shapes.

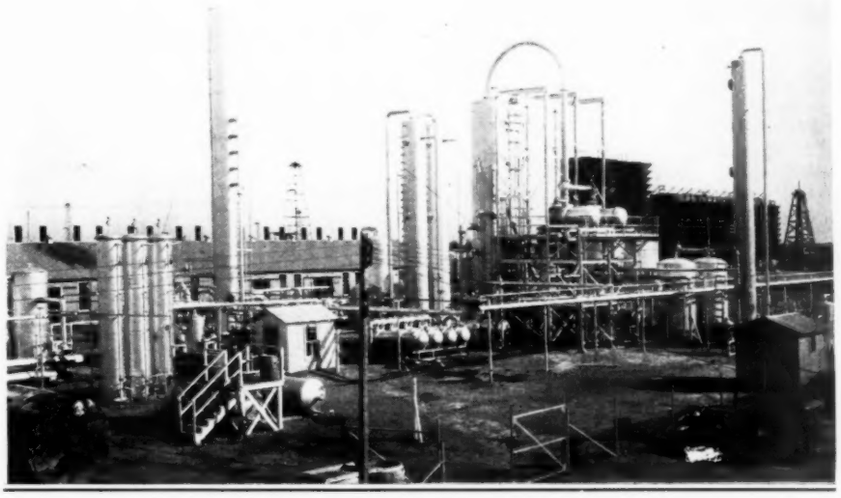
5. Carbonaceous materials can be carbonized at low temperatures and then activated with either an alkali-acid treatment or superheated steam at high temperatures. Activated carbons also exhibit a true relative acidity. There are three commercial types of activated carbon, namely, decolorizing, adsorbing and metal precipitating.

Decolorizing Oils

(a) Decolorizing acid-alkali treated oils.

Fullers earth free of any water soluble salts, acids and alkalies decolorizes as much pure sap brown as will an amount of weak acid which is equal to the relative acidity of the fullers earth. As much alkali can be washed from the fullers earth cake as will neutralize the relative acidity of it. The color impregnated fullers earth cake can be dried without burning out the color compound and reused to decolorize practically the same amount of sap brown.

Exactly the same process ensues when acid-alkali treated oils are decolorized with fullers earth. The color compound is precipitated by active hydrogen and caustic soda is freed. Naturally when the freed caustic soda is equal to or greater than the relative acidity of the fullers earth, it will reunite with the precipitated color compound, thereby causing reversibility of catalytic action or prevent the formation of active hydrogen. The caustic soda usually saponifies some of the oil, but in some cases it combines loosely with the silica content of the fullers earth. Consequently neither the color compound nor the caustic soda is adsorbed by the fullers earth.



The Carter Oil Co.'s natural gasoline plant in Seminole, Okla., region.

The color compound and the caustic soda can be burned out or removed by means of chemicals and the so-called reactivated fullers earth can be used again and again to decolorize acid-alkali treated oils. However, after continued reuse the fullers earth gradually becomes more inert until it no longer exhibits a true relative acidity. This inert fullers earth can be reactivated or re-energized by treating it with strong alkalies like caustic soda or fusing it with sodium carbonate and precipitating it from solution by a proper acid treatment. The material must exhibit a true relative acidity or it will not decolorize oils. The silica content is in a pectoid silicic acid state that evidently emits energy to form active hydrogen.

Activated carbons decolorize acid-alkali treated oils in exactly the same manner. They also become inert upon continued reuse and do not then exhibit a relative acidity. Hence, the catalyst loses only a small amount of energy which produces the active hydrogen which decolorizes the oil. It is a low temperature hydrogenation process.

(b) Decolorizing acid-treated oils.

If concentrated sulphuric acid be poured into a thick, warm solution of sap brown, a violent reaction ensues during which hydrogen, sulphur dioxide and other gases escape. If the reaction is suddenly stopped by addition of water, and if the partially carbonized sap brown be extracted with water, a red color will be obtained; and when diluted more a yellow color will be obtained. These red and yellow colors are similar to red and yellow color taken from acid oils. The precipitation of these colors is different from that explained above because they contain no sodium. Calcium oxide will precipitate these acid red and yellow colors.

Certain activated bentonites (zeolites), which contain a calcium, magnesium and possibly a small sodium content along with energized pectoid silicic acid and an aluminum hydrate or oxide content, all loosely combined and intimately associated, will decolorize acid oils much more efficiently than fullers earth, because the calcium and magnesium content precipitate part of the color which fullers earth does not. The active hydrogen formed by the energized bentonite also acts like that produced by fullers earth. Activated bentonite has a much greater relative acidity than fullers earth; consequently it has a greater decolorizing power.

Activated bentonite usually has some iron sulphate which breaks down into iron hydrate and iron oxide and produces both oxidation and some decolorizing at the temperatures used in decolorizing acid oils. Furthermore, considerable sulphur dioxide is liberated during acid oil decolorizing, and it is a well-known decolorizing agent.

A Low Temperature Hydrogenation of Red Polarine Oil

(a) If hydrogen gas be sealed in thin iron cans under about two pounds of pressure and be immersed in red polarine oil at a temperature slightly below the boiling point of water for about two hours, the red polarine oil will become redder and will contain some water. This does not occur when hydrogen gas is passed into red polarine oil.

It is evident that some hydrogen passes through the thin can in an active state. It probably polymerizes certain parts of the oil, freeing some water by means of OH ions which combine to produce water and nascent oxygen, which increases the color in the oil by oxidation.

Fullers earth is used to dewater certain pine oils to produce solvenol, used as a solvent in making powder. Doubtless this result is obtained by means of active hydrogen being produced by fullers earth. This action is like that of the dewatering enzymes.

(b) Colors in oils are also intensified when either steam or hydrogen is passed through the discharge of a Ford coil in a partial vacuum in the presence of boiling oil.

(c) Colors in oils are also intensified when mixed with moist conductive carbon particles and agitated while a current of electricity is passed through them.

(d) Colors in oils are changed by enzymes in potato juice.

High Temperature and Pressure Hydrogenation of Oils

Catalysts are used in high temperature and pressure hydrogenation of oils to produce active hydrogen. The high temperature and pressure either prepare the oils in the proper state for the active hydrogen to combine with it or slightly change the nature of the active hydrogen or prevent undesirable chemical reactions or all three of these factors are simultaneously operative. It is evident that active hydrogen under proper conditions is essential for high temperature and pressure hydrogenation of oils and that the energy state is at least in part produced by the catalyst, heat and pressure.

Catalytic Actions of Enzymes

All true active enzymes exhibit a relative acidity by producing active hydrogen. Some enzymes oxidize and some reduce; while others hydrolyze and others dehydrolyze only certain organic compounds. All enzymes are reversible to a certain extent due to the nature of the catalyzed products. Each enzyme works only on certain substances, consequently their active hydrogen is more or less specific and in some way different. All enzymes upon reuse gradually lose the power to exhibit a relative acidity and finally become inert.

There are anti-enzymes which prevent certain enzymatic actions by the prevention of the formation or the neutralization of the active hydrogen. There are coenzymes which activate certain enzymes so they will produce active hydrogen. Vitamines and ultra-violet light also energize or activate certain enzymes so they will free active hydrogen at least more efficiently.

Adsorption of Gases, Liquids and Solids

There are three types of activated carbon. One decolorizes oils, sugars, etc.; one absorbs gasoline and other gases, and one precipitates gold from cyanide solutions. They are energized or activated slightly different but each forms active hydrogen. Their active hydrogen is slightly different because each form of activated carbon does its special work better than the other two forms will do.

One writer has described two kinds of hydrogen after he passed it through charcoal surrounded by liquid air. It is possible that these two kinds of hydrogen were due to differently activated carbon in the charcoal.

Some writers even claim that growing root tips emit mitogenetic rays of wave lengths of near that of ultra-violet light which is known to be able to make active hydrogen. So if this be true, the mitogenctic rays are more probably due to emitions of enzymes than to the physical phenomenon of cell division.

It is well known that butterfly wings emit some sort of rays or energy because they will be photographed when placed on photographic plates in dark rooms. Hence, it is plausible that catalysts do emit energy. And if they do, this energy must be taken into consideration in dealing with most cases of adsorption.

Hydrogen passed through platinum and pallidium is in an active state. The active hydrogen held by platinum and pallidium appears to be loosely combined as a solid pectoid acid. It gradually dissipates.

Silica gel and activated clays are known to produce active hydrogen. Their retention of sulphur dioxide is possibly due to the formation of unstable sulphurous acid with H and OH ions.

The greater retention or alleged adsorption of gasoline by activated coconut char than silica gel and activated bentonite is doubtless in some way associated with its greater relative acidity. This is certainly true of highly efficient decolorizing carbons which excel silica gel and activated bentonite in decolorizing power. Hence, it is possible that the gasoline is loosely polymerized and held by the coconut char since it is readily driven off with heat and gradually dissipates.

It is a noteworthy fact that activated carbons and carbon containing substances such as enzymes, and silica or silica-containing materials are the only substances that produce catalytic actions efficiently within the range of living conditions. Nature activates carbon-containing materials such as enzymes by means of ancestral or inherited matter exposed to the sunlight, more especially to ultra-violet rays. It can also activate carbonaceous matter in the region of volcanoes by heat, pressure and superheated steam. It can and does even synthesize carbonaceous matter from elemental carbon and this material can be activated by natural means. Nature produces certain silica-containing materials such as fullers earth, bentonite, etc., which it can and does activate primarily by sulphuric acid.

Carbon is the only element which forms extremely varied and huge molecules. It is both a base and acid. It is to the organic realm what silicon is to the inorganic realm.

Some activated carbons are almost as complicated in chemical powers as are filterable disease germs and protoplasms, but they do not contain the ancestral or time element.

Man can transform energy into electricity and produce rays comparable to natural ultra-violet light which works like the energy emitted by some catalysts. He can synthesize various organic materials but he cannot synthesize the inherited ancestral or time element bound up in living matter. This ancestral or time element is the chief difference between vital and inorganic catalytic actions.

All elements can under certain conditions act more or less as catalysts, but these conditions usually preclude that of living matter. Uranium breaks down into lead and radium, which emits energy and produces helium, but this action cannot be hastened and slowed as can true catalytic actions.

The energy freed by various catalytic actions within the earth and that in the region of the outer atmosphere by the sunlight possibly renews and produces the earth charge of electricity. Hence, catalytic actions have vast importance in both the organic and inorganic realms. Electricity itself is made during several vital processes by means of catalytic action. Hence, it may be nothing more than energized near ultimate divisions of matter.

It is significant that certain natural and artificial rays will produce certain changes in substances which are comparable to certain catalytic actions which are associated with active hydrogen. Consequently, if most catalytic actions and adsorption phenomena are due to energy emitions from energized catalysts which produce many forms of active hydrogen, it now seems possible that at least some different forms of active hydrogen might be produced under proper conditions without catalysts.

It appears evident from this view of catalytic actions that the proton and electron are not the ultimate division of matter or otherwise the different kinds of active hydrogen are produced by some entirely unknown means.

At any rate catalysts and adsorbers are special materials and most of them are specially activated or energized. Most of them exhibit a true relative acidity which is directly connected with their catalytic actions and many of them produce active hydrogen which acts only on certain substances. Hence their active hydrogen is different in some way. The active hydrogen is evidently produced by energized catalysts and adsorbers through a loss of energy because they wear out or become inert upon continued reuse.

The Petreco Process eliminates even the slightest uncertainty of results. What it will do has been demonstrated continuously for more than twenty years.

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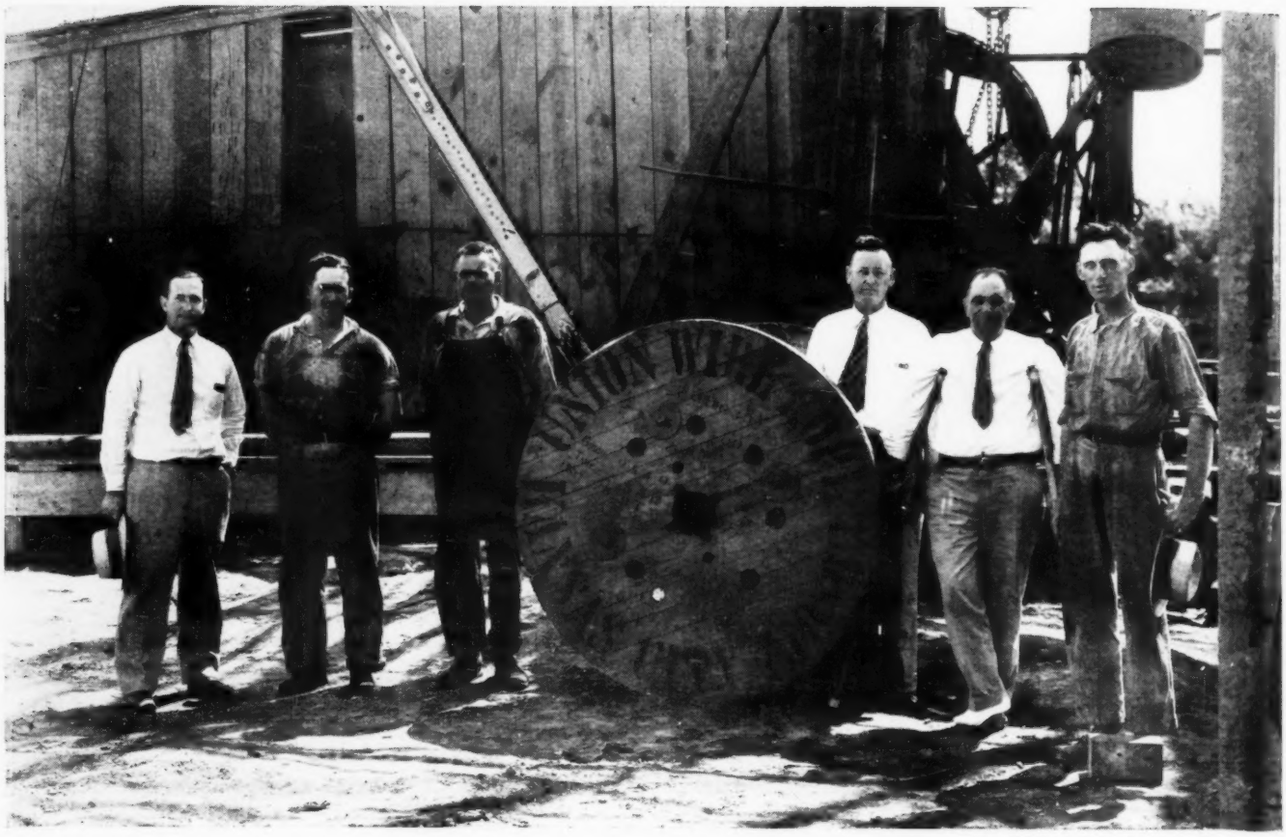

UNION wire Lines are still going strong in the Seminole Field..

Hundreds of thousands of feet of hole have been made in the Seminole Field with UNION Wire Lines. And these wire lines are still going strong in this district—giving their usual satisfactory and economical service.

Shown above is the Prairie Oil & Gas Company's Sager No. 1, Sec 8-9-6, O'Mara Drilling Company, contractors. The men, left to right, are: Jas. A. Undercofler, Union Wire Rope Corp.; J. B. O'Mara, Jr., Contractor; Bob Farbro, Tool Dresser; Geo. A. Jones, Manager, Jarecki Mfg. Co., at Seminole; O.J.Bachman, Sup't, Prairie Oil & Gas Co.; and W. O. Batson, Farm Boss.

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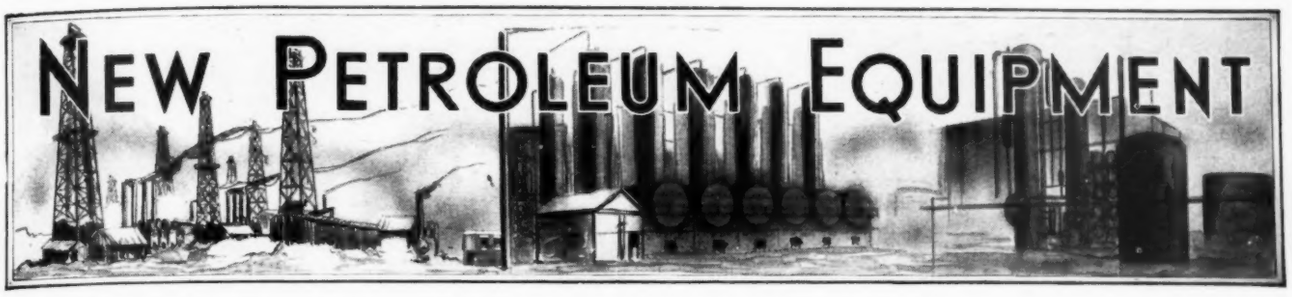


Shafer Roller-Bearing Normal Duty Units

AN entirely new line of Shafer self-aligning roller-bearing units for normal duty applications has recently been announced by the Shafer Bearing Corporation, Chicago, Ill. The Shafer double row self-aligning roller bearings as used in the standard duty units are now available in these lighter weight, compact, simpler housings. The normal duty units are furnished as pillow blocks, flange units and take-up units, in a full range of shaft sizes from three-quarters of an inch to three inches.

The inner race of the bearing is extended on one end only and fastened to the shaft by a special locking collar, providing ample capacity for the intended service and a simplified application of the unit on the shaft. The sealing of the normal duty unit is accomplished into the housing or cover. Between these stampings is a 3/32 fibre washer which will be a slip fit on the extended cone. The seal is said to effectively exclude dirt and other abrasive materials, retain lubricant and prevent leakage.

New Buhl Paint Spraying Compressor

THE Buhl Company, Chicago, Illinois, announces the development of a 36-foot portable compressor for use with pipe line paint spraying outfits, known as the Buhl FJ-36. It is light, compact, built for heavy-duty service. The FJ-36 has a 2-cylinder, 3 by 3¼ water-cooled compressor, with force feed lubrication, direct connected through the Buhl metallic flexible coupling to a 4-cylinder Fuller & Johnson engine. Buhl patented trouble-proof valves and the new Buhl slowdown and acceleration control are outstanding features. The engine is equipped with a fuel pump and gasoline strainer. Entire unit is enclosed in steel housing which can be locked. Air cleaners, unloaders, gauges, service valves, radiator guard, etc., are regular equipment. Overall dimensions on steel wheels, 64 inches long by 30 inches wide by 43 inches high, weight on steel wheels 990 pounds, on skids 810 pounds. Can be furnished as shown on two-wheel pneumatic tired spring trailer, on steel wheels, or on skids.

Tag Steam Trap

THE C. J. Tagliabue Manufacturing Company of Brooklyn, N. Y., is now offering to the trade a new and unique steam trap on a 30-day free trial offer.

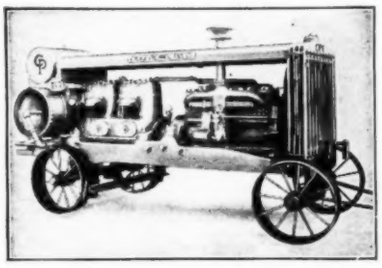
There are several outstanding features of this new steam trap. The new and exclusive differential setting feature makes it possible for the Tag Steam Trap to discharge condensate at a temperature corresponding to a uniform differential pressure from 0 to 20 pounds below the operating steam pressure. If the trap is set to discharge condensate at a temperature corresponding to as much as 20 pounds less than the operating steam pressure, it will discharge the condensate at this differential regardless of whether the steam pressure is 50 pounds, 75 pounds or 125 pounds and without any further adjustment of the differential setting.

There are two reversible and renewable Monel seats and discs in every trap. Simply by unscrewing and reversing the seat the outlet end becomes a new seat.

Full details of this new Tag Steam Trap and the company's selling policy may be secured by addressing the manufacturers.

Chicago Pneumatic Portable Compressor

THE latest addition to the CP line of portable compressors is a four-cylinder-in-line compressor which has been combined with a six-cylinder heavy duty Hercules motor to produce a unit of exceptional smoothness, reliability and economy.



The compressor is of the vertical, four-cylinder, single-acting type. The cylinders, which are completely water-jacketed, are cast in pairs and bolted to the crankcase. They are first bored and then ground to exact size on a precision grinder, assuring absolute roundness, which prevents leakage of air and oil by the pistons. The cylinder heads are cast in pairs.

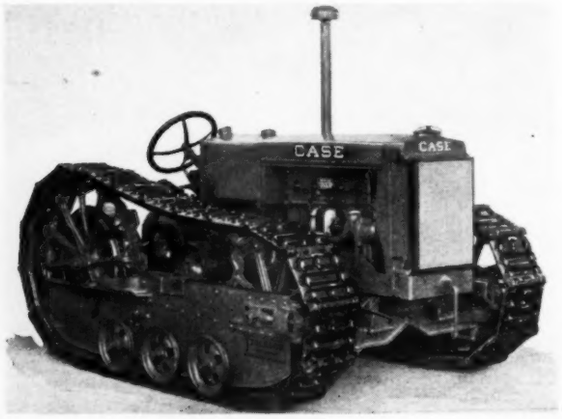
This new compressor of 360 cu. feet per minute capacity permits the use of additional rock drills, clay diggers, backfill tampers and similar pneumatic tools. It may be mounted on steel wheels, or wide flanged solid rubber tired wheels with roller bearings. It can also be furnished with skids for semi-portable use or for truck mounting. It is also available mounted on a CP trailer, equipped with springs, wide flanged solid-tired wheels.

The deck on which the compressor and engine are assembled is a one-piece steel casting of great strength and rigidity. The air receiver is securely held in place by two brackets clamped down by threaded rods passing through the deck. Upon these saddles is mounted a gasoline tank, made of lead-coated stock and provided with a cap which can be locked. A gasoline strainer and a water and sediment trap is provided in the line between the tank and the carburetor.

Full details of this new portable compressor unit may be secured from the Chicago Pneumatic Tool Company, New York City.

Case-Trackson Crawler Tractor

THE new Model CD Case-Trackson Crawler Tractor has been announced by the Trackson Co., Milwaukee, Wis., manufacturers. The unit is powered by the Case "CI" tractor, which is made by the J. I. Case Co., Racine, Wis.



This combination of two well-known machines has been developed to meet the power needs of thousands of industrial users who require a flexible, economical unit that is able to work in any ground or weather conditions, and that is suited both to drawbar use and to the operation of other equipment, state the manufacturers. It has a low speed which provides tremendous power for heavy hauling, a medium speed with plenty of power for average jobs, and a high speed for light drawbar work and quick return trips.

One of the notable advantages of this crawler tractor is the clean-cut, open design and wide clearance between the crawler and motor, which provides for quick and secure in-building of extra equipment, such as hoists, bulldozers, one-man graders, etc.

Because of its flexible power, sturdy construction, ability to work in any ground conditions, and adaptability to other equipment, this crawler tractor is suited for all-around power unit for oil field and pipeline operations, dirt-moving and general contracting, highway construction, all kinds of hauling and other jobs.

Proportioning Electric Motor Control System

THE Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., has developed a control system based on the equality of ratios. The apparatus incorporates a combination of two parts, namely the electrical transmission system and the associated power unit which can be adjacent to or remote from the controlling instrument. A mechanical inter-connection is required between the power unit and the electrical balancing mechanism. The transmission system operates on the Wheatstone Bridge principle.

The power unit, inherently a motor-driven speed reducer, causes its drive shaft to take a new position whenever the conditions under control, such as temperature, change slightly. If a device such as a valve, or valves, louvers or rheostats are driven by the motor, then their operation tends to correct the change and a condition of equilibrium is approached. In this manner a constant control of temperature, pressure, humidity, liquid level, rates of flow, stoker or pulverized feed, etc., can be attained.

It may be used in conjunction with practically all types of control instruments such as room thermostats, temperature controllers of the expansion type, pressure controllers, pyrometers, certain types of flow meters, etc. Existing instruments require slight modification to make them applicable but the revisions usually are simple.

Beaver ½ to 2-inch Portable Machine

THE BEAVER "Model A" pipe machine is announced by The Borden Company, Warren, Ohio. It is an extremely simple, rugged and convenient machine that will cut, thread and ream one-half to two-inch pipe — steel, wrought iron, brass or cast iron, that is supplied with a stand for easy portability.

Model "A" Beaver Pipe Machine.

Three opening die heads (¼ by ¾-inch, 1 by 1¼-inch, and 1½ by 2-inch) are supplied. The dies are adjustable for over, under or standard. It is not necessary to back off over finished threads, insuring great economy in operating time and die replacement.

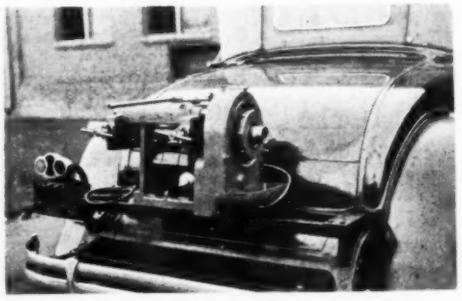
The unit is equipped with a one-half horsepower Universal motor, reversible at the switch and connected with flexible coupling. It operates from a regular 110-volt light line. The oil pump is mounted on the outside for convenience in repacking, cleaning, etc.

The die head can be tilted back out of the way (not necessary to take it off) when cutting and threading up to 12 inches using a Universal shaft and Geared Die Stocks and pipe cutters.

Model A Beaver Pipe Machine, net weight 330 pounds, complete for threading one-half to two inches, is sold for $345.00.

Portable Electric Threader

THE Axelson Portable Threader unit for threading one-half to two-inch pipe with considerable speed and ease is offered the trade by Axelson Manufacturing Company, Los Angeles. The unit is a compact, sturdy one weighing less than 190 pounds, which may be attached to any convenient location and connected to a standard light socket, or if the work to be done is heavy or long may be temporarily secured to a bench or table by suitable bolts through holes provided in the base.



The unit is powered by a Universal Reversible one-half horsepower motor and can be used on any 110-volt circuit. A standard square die is revolved on the pipe instead of revolving a bulky length of pipe through a die head. The material to be threaded is held in place by two self-centering jaw chucks which assure accurate alignment.

Full information on this new portable threader, which may be mounted on a car or elsewhere, may be secured from the Axelson Manufacturing Company.

HIGH ANTIKNOCK RATING

The best possible motor fuel from your cracked gasoline at lowest cost

write us for details

LOW GUM

THE GRAY PROCESSES CORPORATION

961 FRELINGHUYSEN AVENUE

NEWARK, NEW JERSEY

Gasoline Mileage Tester

PENBERTHY INJECTOR CO., Detroit, Mich., has developed an improved and simplified combination flowscope and tester for determining the mile per gallon of gasoline. The tester consists essentially of an accurate measuring glass bulb, a venting arrangement and two lengths of rubber tubing. One tube conveys the gasoline from the fuel line to the measuring bulb; the other connects the bulb and the carburetor.

The tester operates on the principle of the syphon; for priming, a syringe is provided in the tube that connects the fuel line and tester. No pump is needed and there are no electrical connections. Every drop of gasoline that goes to the carburetor passes in plain sight through the glass bulb.

When not determining the actual miles per gallon the tester can be used as flowscope to determine the relative rate of gasoline consumption under various driving conditions. Any change in the rate of gasoline flow to the carburetor can at once be seen in the glass bulb neck.

A hook at the top of the protective frame for the glass bulb permits suspension from the door glass; two vacuum cups at the bottom hold the tester firmly against the door.

New Sucker Rod Development

First Step.

Second Step.

Third Step.

OIL WELL SUPPLY COMPANY announces a new sucker rod manufactured by a new and highly specialized practice to secure the maximum in three prime requisites—strength, toughness, and ductility.

To do this "Oilwell" has originated a unique Triple Heat Treatment to which each rod is subjected so that a rod heat treated over its entire length results.

The first step in "Oilwell's" Triple Treatment is normalizing, after the forging of the ends of the rods. This treatment relieves internal strains set up in the forging operation and likewise gives a partial refinement of the grain structure.

The second step in "Oilwell's" progressive Triple Heat Treatment is a grain refining operation by quenching. This consists of heating the full length of the rod to a point somewhat above its critical point and then while this temperature exists, quickly plunging the rod into water. This method practiced under rigid pyrometer control of furnace temperature produces a very fine grain which adds greatly to the strength of the steel. This quenching treatment, however, causes the steel to be brittle so that a further heat treatment is needed to secure the necessary ductility.

The third step in "Oilwell's" Triple Treatment consists of drawing the temper exactly as the best tool steels are tempered and drawn. This provides ductility and is accomplished by again heating the full length of rod but this time to a lesser temperature than in the preceding quenching operation. The drawing furnace is carefully controlled to maintain the rods at proper heat over a period of several hours, after which the rods are allowed to cool in air. This completes the heat treat process, after which the threading is done.

As each step in "Oilwell's" Triple Treatment is completed, a careful inspection is made for any defects and sample rods are taken for laboratory tests of tensile strength, hardness, ductility and micro-structure.

This very extensive process of "Oilwell's" Triple Treatment is followed to produce a superior new rod that will contribute toward reducing lifting costs.

Midwest Welding Ells

THE Midwest Piping & Supply Company, Inc., St. Louis, Mo., has announced the manufacture of Midwest Welding Ells of 90 or 45 degree angles, after two years of research.

A special compression sizing operation that has been developed by the company assures that these fittings are to exact radius and sectional diameter and in perfect round, according to the makers. Every Ell is subjected to a hydrostatic test pressure 25 per cent greater than the mill test of the corresponding pipe.

These Ells have tangents that make it possible to quickly and accurately line up the pipe and fitting. The welds are more accessible and are removed from the point of maximum bending stress. One-quarter inch of tangent is provided for each inch of pipe diameter; thus an 8-inch Ell has tangents two inches long.

Each Midwest Welding Ell is made from one piece of plate by a special process developed and patented by Midwest; there is one welded longitudinal seam along the inner circumference. The final working of the metal is in compression at a forging heat, thus normalizing and refining the metal in the plate and the weld.

Hopper Machine Works Liner Setter

A NEW liner setter brought out by the Hopper Machine Works, Inc., of Bakersfield, Calif., has among its outstanding features a solid adapter, the insurance of a smooth, sure entrance and the absence of a delicate latch mechanism.

There are no holes in the walls of the adapter to weaken it. It has an inside bevel at the top that makes for a sure, smooth entrance of the mandrel, which has a corresponding bevel on the bottom. Provision is made for packing in the head so that it can be set down on the adapter and circulation provided through the perforations in the pipe below. When on production, the bailer and tools can be run through the adapter without injury to the latch mechanism, which consists of two expanding jaws on the headpiece with their two adjacent ends pivoted.

When unhooking from the liner, the head is turned—either to the right or left—until it stops. The head is raised until the drill pipe will rotate one-quarter turn; then, in lifting up, the tapered keys will collapse the expanding jaws and allow the head to be released. In hooking on to the liner, the head will enter the adapter with ease because of the beveled entrance. As the shank enters, the two rings are contracted smoothly and gradually as they come in contact with the beveled top of the adapter. The head will enter the adapter in any position.

Heavy Duty Twin Disc Clutch

AN entirely new departure in clutch manufacturing is announced by the Twin Disc Clutch Company, Racine, Wis., in making its new Twin Disc C. R. Type, which is especially designed for heavy duty applications.

In certain heavy duty installations when the clutch proper is the driving member the operating mechanism frequently will tend to extend radially outward because of centrifugal force on the clamping member and this new disc clutch is particularly designed to overcome this action. Centrifugal force will cause the inner ends of the levers to fly outward which in turn will apply tension to the toggle links, which are connected to the clamping plate. The greater the action of centrifugal force the greater will be the pull tending to draw the clamping plate away from the fraction discs or driving plate.

When the clutch is being operated to engage it, the initial movement of the clamping plate is comparatively fast, but as it reaches its closed position it slows down, due to the straightening of the toggle links which then exert their maximum pressure. Provision is made to carry the links over the center, and the inner ends of the levers are also moved beyond the true radial line, in order to insure a locked engaged position.

When releasing the clutch, the first movement is a powerful one that insures the breaking loose of the plates and this is followed by a more rapid motion to the position of full release. Adjustment is performed in the usual manner, and the levers are operated by a simple form of sliding sleeve. This design is adapted for duplex installations and for a given diameter and applied power.

Standardized Markings on All Oxweld Welding Rods

THE Linde Air Products Company, 30 East 42nd Street, New York, N. Y., has announced a new standardized set of markings on all Oxweld welding rods. With three exceptions, all rods ⅛ inch in diameter and larger are stamped with the name "Oxweld" as well as the number and type of rod. On the smaller sizes of welding rods where it is not possible to stamp the name, the boxes in which the rods are shipped are plainly marked "Oxweld" with the number and type.

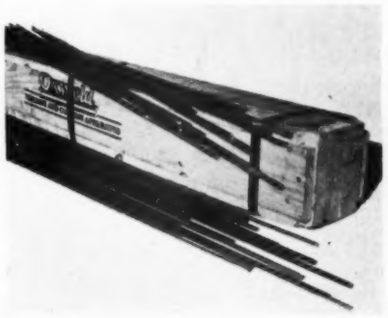


Fig. 1. Boxes and welding rods are plainly marked "Oxweld."

Oxweld No. 1 High Test Patented Steel Rod, marked "Oxweld No. 1 H. T. Patented," is for use wherever welds of uniform high strength are required in steel plate, sheets, structural shapes, pipe, steel castings, etc.

Oxweld No. 2 High Carbon Steel Rod, marked "Oxweld No. 2 Steel" is for use when welding high carbon steel. For cold rolled shafting, or nickel or chrome steel, Oxweld No. 3 Nickel Steel Rod marked, "Oxweld No. 3 Steel," is the proper welding rod. For manganese steel welding there is the Oxweld No. 4 Manganese Steel Rod. The ends of each rod are painted green for identification.

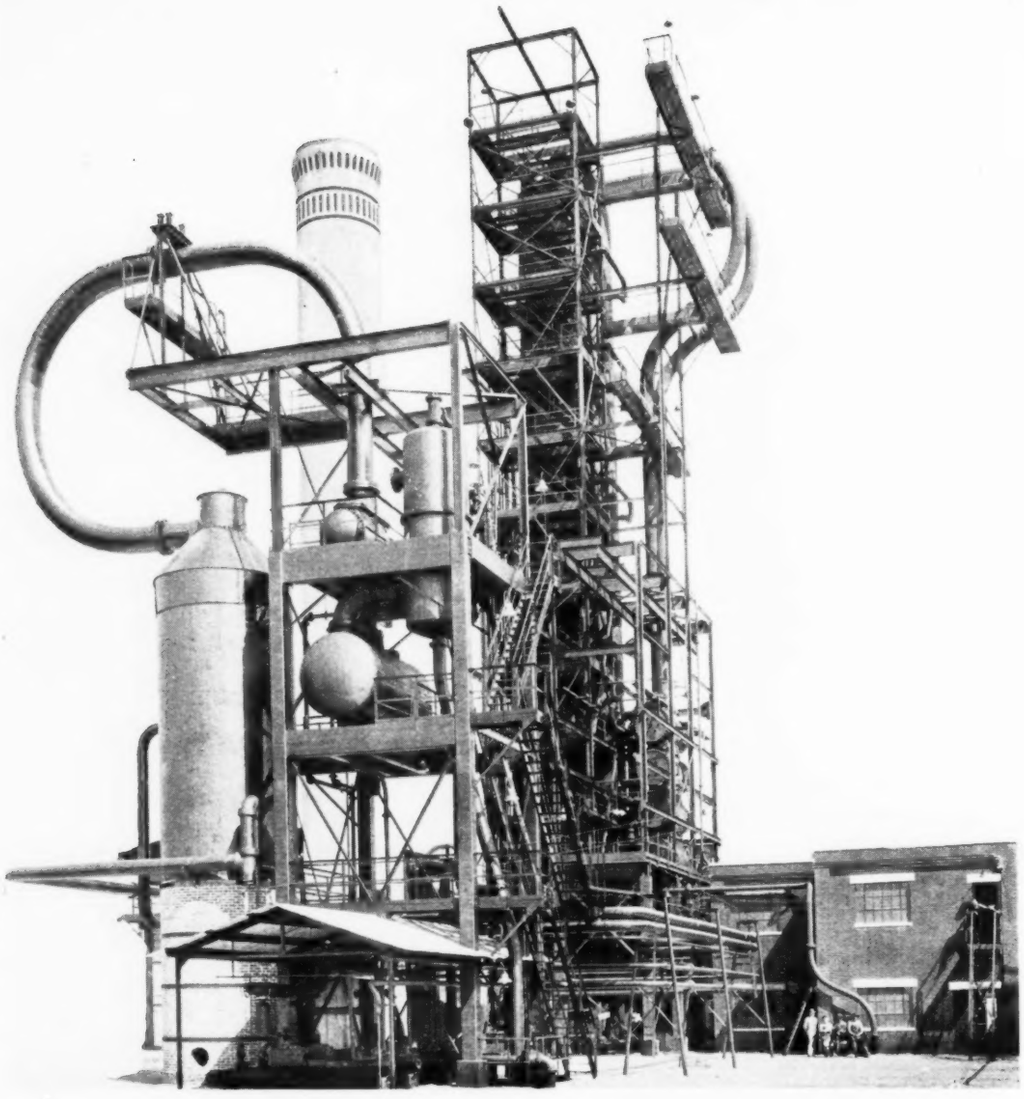
Copper-coated Oxweld No. 7 Drawn Iron Rods, for welding steel plate, sheet, structural shapes, pipe, etc., are marked "Oxweld No. 7."

Oxweld No. 9 Cast Iron Alloy Rods, which are for use when welding gray iron castings, are marked "Oxweld C. I."

There are nine different non-ferrous welding rods. For high strength welds in copper, brass or bronze, or for bronze-welding malleable iron, steel or cast iron, there are the non-fuming Oxweld No. 21 H. S. (High Strength) Patented Bronze Rods, which are marked "Oxweld No. 21 H. S. Bronze Patented."

For bronze-welding cast iron and for welding brass, bronze, etc., there are also the Oxweld No. 10 Bronze Rods, which are marked "Oxweld No. 10 Bronze"; and Oxweld No. 11 Drawn Manganese Bronze Rod, stamped "Oxweld Manganese Bronze." Oxweld No. 13 Drawn Brass Rods, used on sheet or cast brass, are all stamped "Oxweld Brass." For rail bonding and metal furniture manufacture there is the Oxweld No. 19 Cupro Rod, which is marked "Oxweld Cupro"

There are three different types of aluminum welding rods. For sheet aluminum work there is the Oxweld No. 14 Drawn Aluminum Rod. These are not marked. The box, however, is stamped "Oxweld." For aluminum castings there is the Oxweld No. 15 Lynite Aluminum Rod, marked "Oxweld Lynite." And for cast and sheet aluminum and aluminum alloys there is the Oxweld No. 23 Aluminum Rod, which is labeled "Oxweld No. 23 Aluminum."



Recovery of Lubricating Oil Distillates Under Vacuum

The distillation unit shown will process 10,000 barrels of Mid-Continent Crude per day running to 8-9% heavy flux bottoms. A flash tower, operating under vacuum, receives the residual from the atmospheric stage and recovers cylinder oil distillate overhead. No heat is added between the two towers.

This installation permits the recovery of maximum yields of lubricating stock with minimum operating and investment costs.

FOSTER WHEELER CORPORATION
165 Broadway, New York, N. Y.

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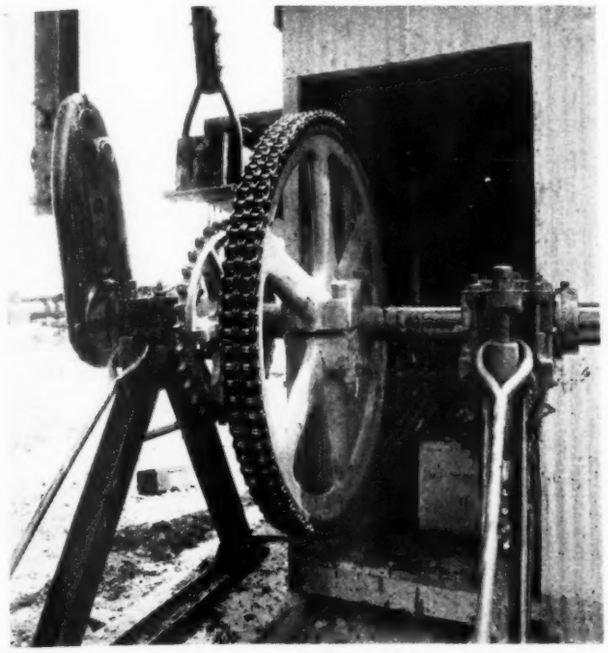
Branches in Principal Oil Centers

FOSTER WHEELER

Parkersburg Chain-Driven Pumping Unit



A NEW chain-driven pumping unit designed primarily for fields where low initial cost and maintenance are paramount factors has been introduced by The Parkersburg Rig & Reel Company, Parkersburg, W. Va.

This unit has been tested in the Gulf Coast and demonstrated unusual economy in operation as well as in erection, according to the makers. Any type walking beam, sampson and jack posts, pitman, counterbalance, crank and shaft, or countershaft, is adaptable to this new Parkersburg pumping unit. For servicing, either bull-rope-driven bull wheels or chain-driven tubing hoist can be used.

It may be operated by gas, oil or electric power, transmitted by "V" belt and chain drives. The teeth on the drive sprocket are cut, assuring smooth as well as efficient operation. Oil-proof housing permitting the chain to run in an oil bath will be supplied if desired.

The simplicity of design and easy accessibility of all parts makes it very low in maintenance. Its compactness dispenses with the need for large expensive housing.

Additional details may be secured by writing the manufacturer.

Protective Paint for Pipe Line

ANNOUNCEMENT has just been made by the American District Steam Company, North Tonawanda, New York, that after over two years experimenting and testing, they have perfected a protective paint of unusual efficiency for use on steam and hot water pipe lines.

The product has been named Adsco Pipe-Kote 505; and, according to the manufacturer, provides several important advantages over ordinary pipe paints in that it is impervious to any degree of heat generated by steam; is practically immune to the action of moisture, dilute acids and alkalis; and while it produces an extremely hard, tenacious coating, it is sufficiently elastic to expand and contract with the pipe without cracking or peeling.

While Pipe-Kote is especially recommended for use on steam and hot water lines, it works with equal effectiveness on gas and water mains, stacks, boiler fronts, bridges, and all other surfaces exposed to extreme or rapid changes of temperature and atmospheric conditions.

Hand-Operated Crane

THE Hoist & Crane Division of Robbins & Myers, Inc., Springfield, Ohio, are manufacturing a new hand-operated crane specifically designed for use in pipe line compression stations and power houses but adaptable to a wide range of other industrial applications.

This new crane is equipped with Hyatt Bearings throughout with the exception of the load hook, which is supported on a Timken roller thrust bearing. The entire construction is welded steel. All gears and pinions are cut from solid alloy steel forgings. Trolley wheels and chain sheaves are of Aremite, a new light weight alloy metal having twice the tensile strength of grey iron. A two-speed hand wheel provides for double speed at half full load. The double helix cam nut is manganese bronze. A roller chain drive results in smoother operation and aids compact construction. The load brake is of twin disc design with steel ratchet and silent pawl. Complete information will be supplied by the manufacturer on request.

Griscom-Russell Gas Cooler

THE ingenious design of the new G-Fin Gas Cooler, which has been developed by The Griscom-Russell Company, 285 Madison Avenues, New York City, has overcome the difficulty of low heat conductivity of air, gases and vapors, by increasing the effective area on the side of the heat transfer surface which is presented to the hot gas or vapor, according to the maker.

This is done by means of radial fins securely fastened to the outside of the tubes through which the cooling medium flows. The hot fluid passes along the channels formed by these fins and the large total fin surface provides many times the heat absorbing area of bare tubes.

Further details of this new Gas Cooler may be secured from the manufacturers. In writing ask for new leaflet describing its construction and special features.

Bullet Type Motors for Deep Well Pumping

DESIGNED especially for deep well pumping service, the construction of these Westinghouse "Bullet Type" vertical hollow shaft motors reflects improvements resulting from years of experience in manufacturing and applying vertical motors to a wide variety of uses.

Many distinctive features are included which contribute to economical and reliable pumping operations. Water cannot drip into motor because of its solid frame weatherproof hood. A jaw type clutch protects the equipment from damage in case of power reversals and provides for easy adjustment of the pump shaft. Other features include directed ventilation, liberally designed cartridge type thrust bearings, dual protected and uniform insulation, interchangeable pre-wound primary core.

This motor is completely described in an illustrated leaflet No. 20529 which may be obtained by writing to the Advertising Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Robert W. Hendee, vice-president of the Oklahoma Natural Gas Corporation, Tulsa, Okla., is on a business trip through the East.

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S. P. Wallace, with the Parkersburg Rig & Reel Company, Tulsa, recently made a trip to Colorado for his company.

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E. L. Rogers, refinery superintendent, formerly with the Continental Oil Company, is now with the East Texas Refineries, Inc., at Longview, Texas. Mr. Rogers was previously located at Albuquerque, N. M.

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A. V. Simonson, foreign representative for the Gaso Pump & Burner Manufacturing Company, Tulsa; Hinderliter Tool Company, Tulsa, and Lufkin Foundry & Machine Co., Lufkin, Texas, visited in Tulsa and Lufkin prior to making a trip to South America.

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W. H. Reardon, petroleum engineer, Shell Petroleum Corporation, has been transferred to Marshall, Okla., from Braman, Okla.

George L. Nye

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George L. Nye of the Tidal Oil Company has been transferred from Maud, Okla., to East Texas, where he is doing production engineering work.

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Fred Hartman, Wabash Drilling Company, has moved from Lawrenceville, Ind., to Washington, Ind.

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L. P. Leonard, refinery superintendent, Globe Oil & Refining Company, has been transferred to Blackwell, Okla., from Cushing, Okla.

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F. D. Hooper, formerly sales manager for the Lidgerwood Manufacturing Company of Elizabeth, New Jersey, has been appointed general sales manager of the Barber-Greene Company of Aurora, Ill. Mr. Hooper received his mechanical engineering and electrical engineering degrees at Sibley College, Cornell University, graduating in 1907. He was employed by the Lackawanna Steel Company (now Bethlehem Steel) and the Boston & Maine Railroad before starting his 24 years of continuous service with the Lidgerwood Manufacturing Company.

F. D. Hooper

R. W. Hendee

Fred A. Nickolson, formerly chemist with the United Oil Company, Pittsburgh, Pa., is now chief chemist for the Elk Refining Company at Weir, W. Va.

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George Morris, president of the Bradford Motor Works, Bradford, Pa., manufacturers of pumping specialties, was recently a visitor in Tulsa, where he gave some golf instruction to "Mickey" Brennan, Mid-Continent manager of the firm.

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P. E. Fluor, general manager of the Fluor Corporation, Ltd., has just returned from a Mid-Continent trip, during which he inspected the progress on the Panhandle-Eastern pipe line. The Fluor Corporation is now installing its third compressor station on this line.

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W. B. Rawson, sales engineer of the Maintenance Engineering Corporation, 1400-02 Conti Street, Houston, Texas, is now in Mexico on a business trip covering Tampico and Mexico City.

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John B. O'Connor, general sales manager of the Clark Bros. Company, Olean, N. Y., has returned East after having completed a trip through the East Texas and other Mid-Continent oil fields.

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J. B. O'Connor

William Woelfin, who for the past five years has supervised the activities of the Petroleum Rectifying Company of California, Long Beach laboratory, has been appointed acting research engineer.

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Joseph A. Slusser, welding foreman, The Sinclair Oil & Gas Company, has been transferred from Smackover, Ark., to Gladewater, Texas.

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M. A. Finney, district superintendent for the Pure Oil Company at Odessa, Texas, has been transferred to the Van (Texas) field.

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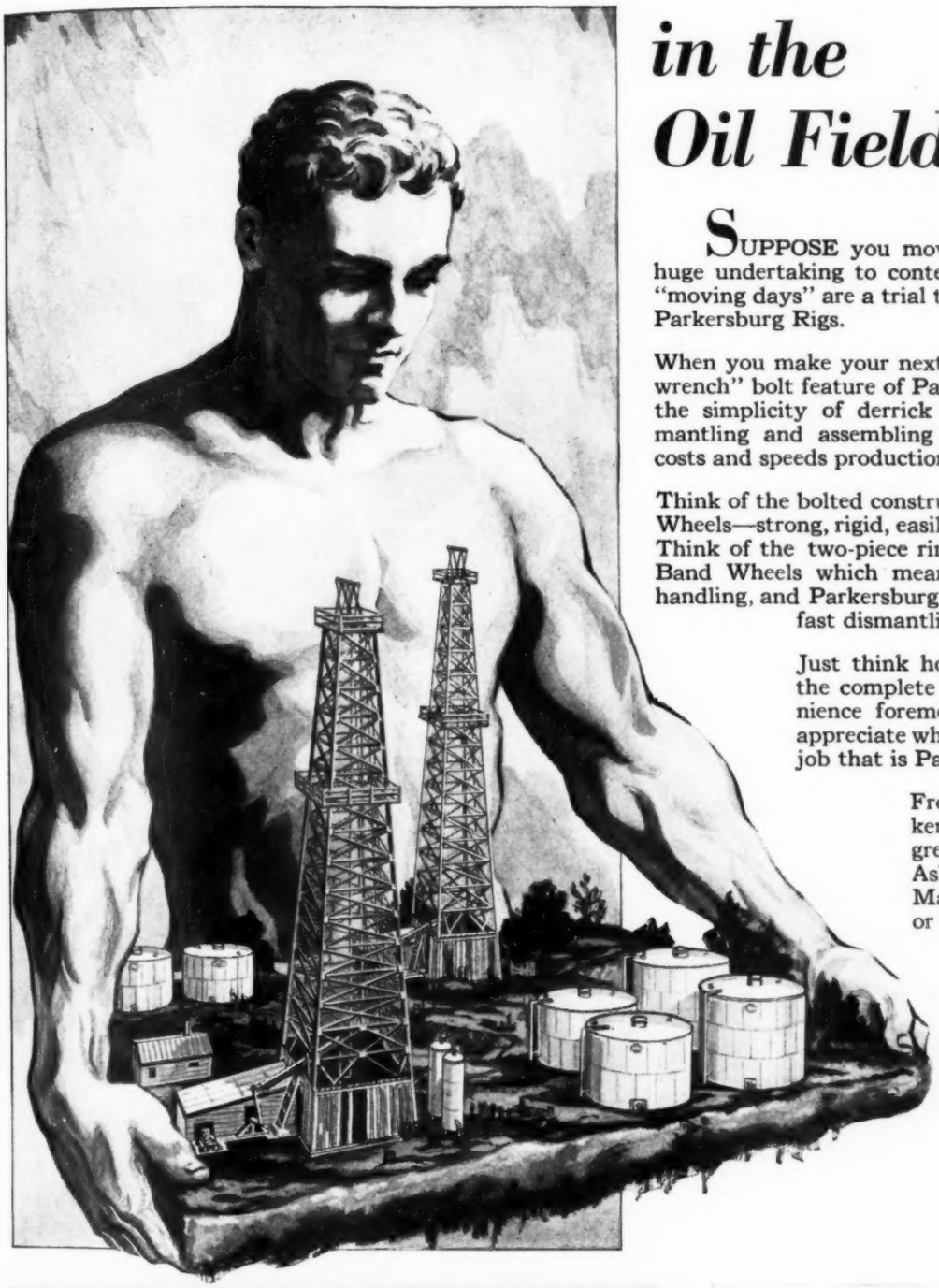
M. N. Aitken, representing The Barrett Company, New York, was a recent visitor in Tulsa, where he called on oil company buyers in the interest of his company.

MOVING DAY



in the Oil Fields

SUPPOSE you moved a Rig every week! A huge undertaking to contemplate. Even infrequent "moving days" are a trial to oil men who do not have Parkersburg Rigs.

When you make your next move, think of the "one-wrench" bolt feature of Parkersburg Steel Derricks—the simplicity of derrick design which makes dismantling and assembling quick and easy—reduces costs and speeds production.

Think of the bolted construction of Parkersburg Steel Wheels—strong, rigid, easily assembled or dismantled. Think of the two-piece rim on Parkersburg Type P Band Wheels which means greater convenience in handling, and Parkersburg Steel Posts, fabricated for fast dismantling and greater portability.

Just think how Parkersburg constructs the complete Rig with the user's convenience foremost in mind and you will appreciate why things move fast on every job that is Parkersburg equipped.

From Derricks to Tanks Parkersburg Quality results in greater Service and Economy. Ask the nearest Parkersburg Man about these advantages, or write for latest Bulletins.

THE PARKERSBURG RIG AND REEL CO.

TRADE MARK REG.

This Seal of Quality and Service on Parkersburg Equipment is Your Guarantee.

FROM DERRICKS TO TANKS

QUALITY AND SERVICE

THE PARKERSBURG RIG AND REEL CO.

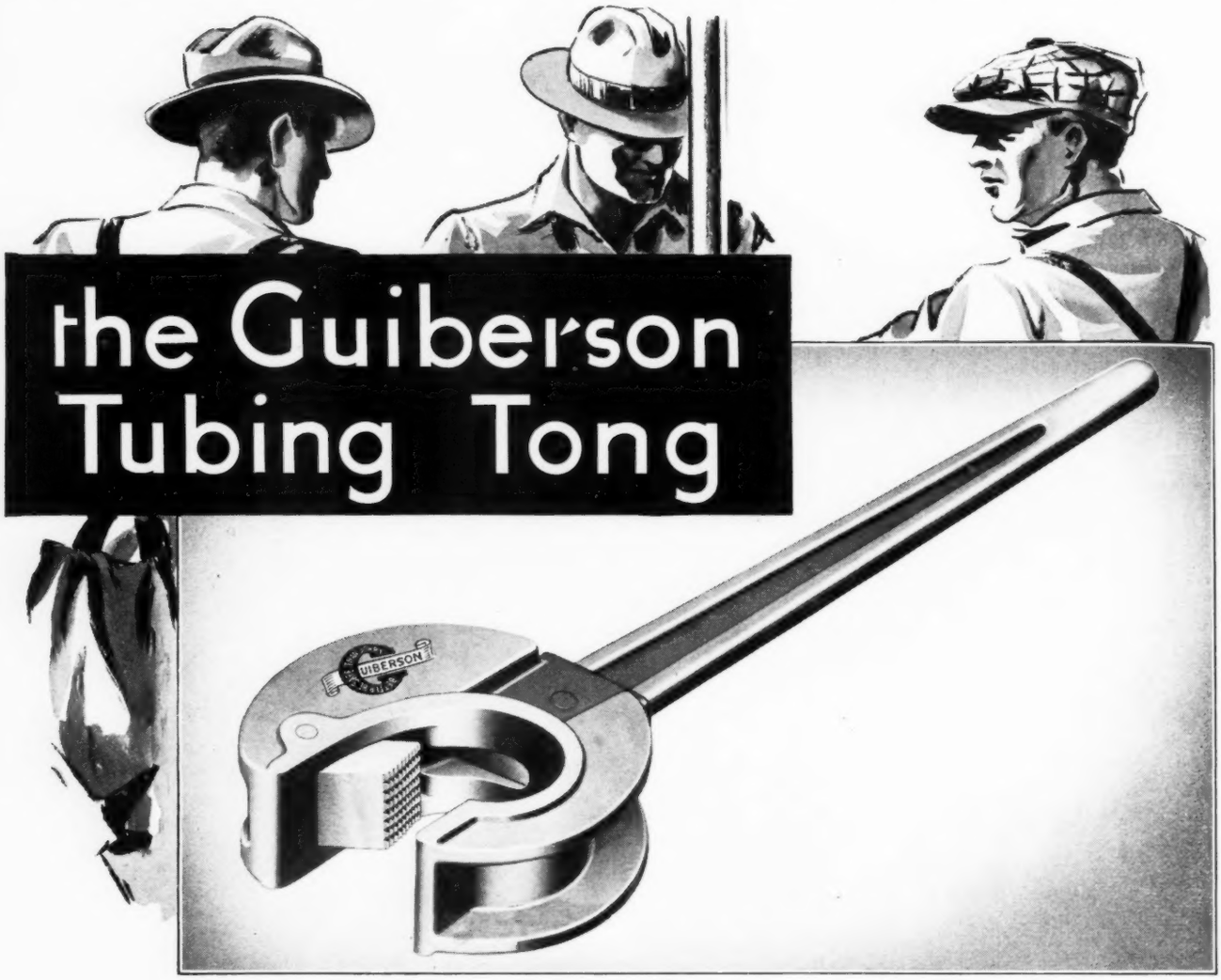
PARKERSBURG, W. VA.

NEW YORK • TULSA • FT. WORTH • HOUSTON

BRANCHES IN ACTIVE FIELDS

CABLE ADDRESS "PARIGREEL"

"CERTAINLY HAS A FIRM HOLD ON THE SITUATION"



That's what they all say when they see the Guiberson *Tubing* Tong take hold of the tubing.

Anybody who has ever handled a Guiberson *Tool Joint* Tong knows what to expect in the Guiberson *Tubing* Tong, even if he's never seen one.

Built on the same principle of automatic action, the Guiberson *Tubing* Tong has all the other fine points of its famous predecessor. It is light in weight, with ample strength for safety. It is easily engaged with the tubing and may be released with one hand. The body is so designed that the entire load that comes on the die is transferred directly to the body. Patent Pending.

"Better Be Safe Than Sorry"
The GUIBERSON CORPORATION
Box 1106, Dallas, Texas
California Branch: 1304 Security Title Ins. Bldg., Los Angeles
504 Wright Bldg., Tulsa
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GUIBERSON

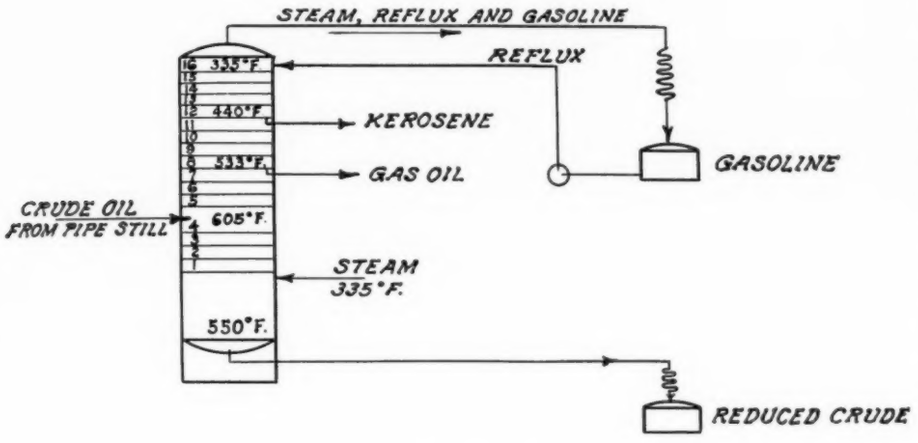
BETTER BE SAFE THAN SORRY

The Fractionation *of* Heavy Oils

Heat Balances and Tower Temperature

By W. L. NELSON[1] *and* DR. MOTT SOUDERS, JR.[2]

IN the preceding article[3] the fundamental laws of fractionation were illustrated by means of a simple two-component mixture. Petroleum oil, however, contains probably thousands of components, and any attempt to apply a rigorous mathematical analysis to its fractionation becomes hopelessly involved. It is necessary, therefore, to adopt simplifications and assumptions based upon a consideration of the fundamental laws and validated by empirical results.



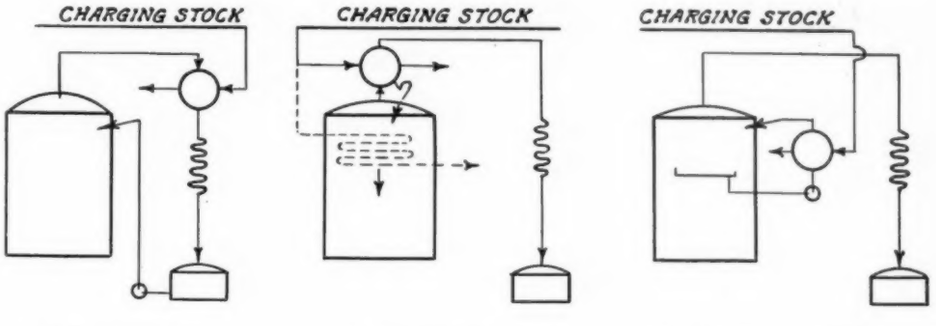
SKETCH No. 1.

Although fractionation in the bubble-tower is an effective means of gaining a separation of oils, perhaps of equal importance is the facility which the bubble-tower affords for the practice of continuous distillation. In the bubble-tower a continuous feed is constantly separated into products of limited boiling range. In this way fractionation accomplishes at the same time two important steps in processing.

Sketch No. 1 is a simple flow diagram of a bubble-tower operation. At the vaporizer temperature of 605 degrees F. the gasoline, kerosene and gas oil are vaporized, but the reduced crude is not vaporized and remains a liquid during its passage through the tower. Unless some cooling is effected, the gasoline, kerosene and gas oil will pass out of the tower as a mixture of vapors. Actually heat is taken from this tower system by means of cold reflux, so that the gasoline, the kerosene and gas oil are cooled and the kerosene and gas oil are condensed.

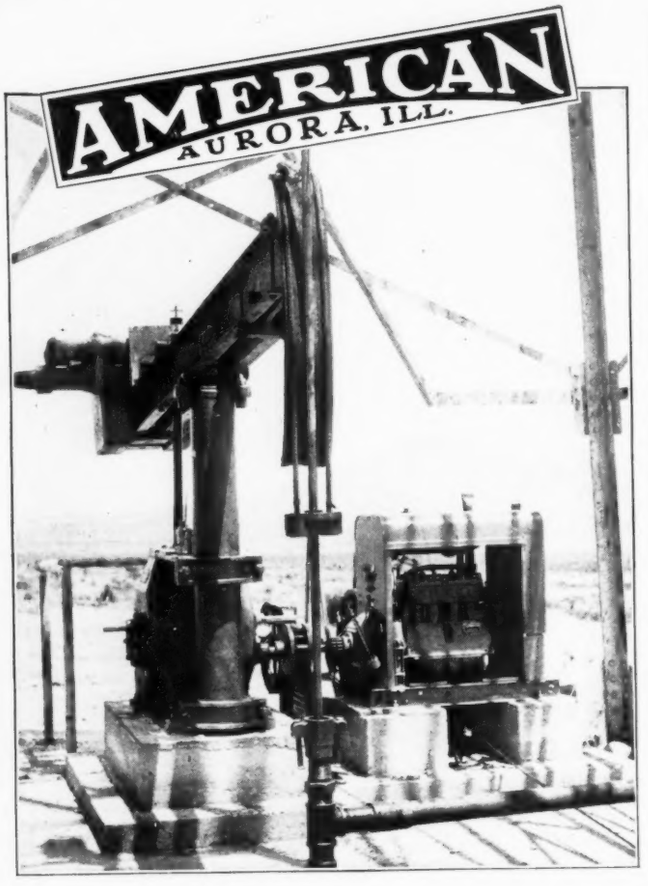
Heat Balances

The application of a heat and material balance to materials entering and leaving a process unit is a familiar engineering practice. Such a balance applied to a fractionating column determines the quantities of heat and materials which must be handled and thus provides a basis for determining the sizes and mechanical features of the tower and its auxiliary equipment, such as condensers, coolers and pumps. The reference or datum temperature employed in the heat balance is not of fundamental importance. The vaporizer temperature is a desirable datum temperature because it may be easily predetermined and because the excess or reflux heat is obtained directly when using this datum. When using the vaporizer temperature as the datum plane, the heat quantities above and below this temperature are balanced one against another. Other designers prefer to use such datum planes as 60 degrees F., or the top tower temperature. A heat balance using either of these datum planes involves as much or more computation than by using the vaporizer temperature. Furthermore, the top temperature datum requires an assumption of the top temperature and this assumption cannot be checked as correct until the heat balance is completed. If a tabulation of total heat quantities above 60 degrees F. for each type of oil, and similar to the steam tables, were available, then the datum plane of 60 degrees F. would be most convenient. Because of the complexity of petroleum oil, such tables



SKETCH No. 2.

[1] Professor of Petroleum Engineering, University of Tulsa.
[2] Consultant Engineer, Ann Arbor, Mich.
[3] Nelson and Souders, this journal, August, 1931.



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sufficiently accurate and simple enough to serve as a basis for design have not been developed.

As an example, a heat balance about the tower system of Sketch No. 1 will be computed. Two thousand barrels per day of Oklahoma City crude oil, as described in Figure I, will be charged to the tower. Tabulation of useful data.[2]

Products	Pct.	G.P.H.	A.P.I.	#/Gal.	#/Hr.	50% B.P.	M.W.*
425 E. P. Gaso.	31	1085	58.5	6.2	6730	280	118
540 E. P. Kero.	12	420	41.5	6.81	2860	490	192
Gas Oil	15	525	35.0	7.08	3720	605	245
Reduced Crude	42	1470	24.8	7.54	11090	.....	.....
Crude Oil†	100	3500	37.3	6.98	24400	.....	.....
Steam	....	....	.....	.....	.....	900	.....	.....

* Actual laboratory data.
† Loss already corrected.

The equilibrium flash yield curve (Figure 1) indicates that a temperature of 605 degrees F. is necessary at 4# gauge end corrected for the partial pressure of the steam in order to vaporize 58 per cent of the crude oil. Thus the temperature of the vaporizer section of the tower must be 605 degrees F.

Assumed Tower Temperatures (To Be Checked Later)		L. H. at Tower Temp.
Top (Gaso)	335° F.	108
Kerosene	440° F.	88
Gas Oil	535° F.	74
Bottom	550° F.	....

Sufficient heat must be removed to cool the gasoline vapor to 335 degrees F., to cool to 440 degrees F. and condense the kerosene vapor, to cool to 535 degrees F. and condense the gas oil vapor, and to cool the reduced crude as a liquid to 550 degrees F. This quantity of heat may be determined by means of a heat-balance which includes all of the above items.

Tower Balance

(a) Gasoline, 6730 (605-335) 0.577 = 1,050,000 B. t. u. Hr.
(b) Kerosene, 2860 (605-440) 0.587 = 277,000 B. t. u. Hr.
(c) Gas Oil, 3720 (605-535) 0.607 = 158,000 B. t. u. Hr.
(d) Reduced Crude, 11090 (605-550) 0.732 = 446,000 B. t. u. Hr.
(e) Kerosene, 2860x88 = 252,000 B. t. u. Hr.
(f) Gas Oil, 3720x74 = 275,000 B. t. u. Hr.
(g) Steam, 900 (335-335) 0.48 = 0 B. t. u. Hr.
Excess or Reflux Heat = 2,458,000 Total B. t. u. Hr.

The specific heat of a vapor[3] was used in items (a), (b) and (c), that of a liquid[4] in item (d). The latent heats[5] correspond to the respective tower temperatures. The reflux heat of 2,458,000 B. t. u. must be removed continuously from the top of the tower during each hour of operation.

Reflux Quantities

Several methods of removing reflux heat are used. Please note Sketch No. 2.

Cold reflux is a reflux material which has a lower temperature than the material in the tower at the point of introduction. It is desirable because the reflux quantity can be definitely and easily controlled.

Hot reflux presents the structural difficulty of supporting heavy reflux condensers above the tower or the use of the troublesome internal cooling coil. The control is not direct, since it depends in part upon the quantity and temperature of the cooling medium.

Circulating reflux necessitates the handling of large quantities of hot liquid. However, the control is more positive than the control of hot reflux, because the speed of the circulating pump may be altered to meet the con-

[2] W. L. Nelson, this journal, February, April and May (1930).
[3] Bahlke and Kay, Ind. and Eng., Ch. 21, p. 942 (1929).
[4] Fortsche and Whitman, Ind. and Eng., Ch. 18, p. 795 (1926).
[5] Miscellaneous Publications of the Bureau of Standards No. 97.

dition of the cooling medium. This type of reflux is useful if the removal of reflux heat is desirable at some point lower in the column than the top.

Regardless of the type of reflux, part of the reflux heat can be recovered by heat exchange. Depending upon temperature and type of reflux employed, the quantity of reflux pumped to the tower will vary. Reflux handled outside the tower, such as the above three examples, may be termed external reflux, and, although the quantity varies, the amount of reflux heat that is removed is independent of the type of reflux; in this case 2,458,000 B. t. u. per hour. As examples, the cold reflux at 80 degrees F., the hot reflux, and the circulating reflux at 235 degrees F. have been computed:

Cold reflux = 2,458,000 ÷ [108 + (335 — 80) 0.587] = 9,540 #/Hr.

Hot reflux = 2,458,000 ÷ 108 = 22,760 #/Hr.

Circulating reflux = 2,458,000 ÷ (335—235) 0.637 = 38,600 #/Hr.

In determining the quantities of reflux liquid (or reflux vapor) within the tower it should be noted that the reflux is always at its boiling point. That is, the *internal* reflux is

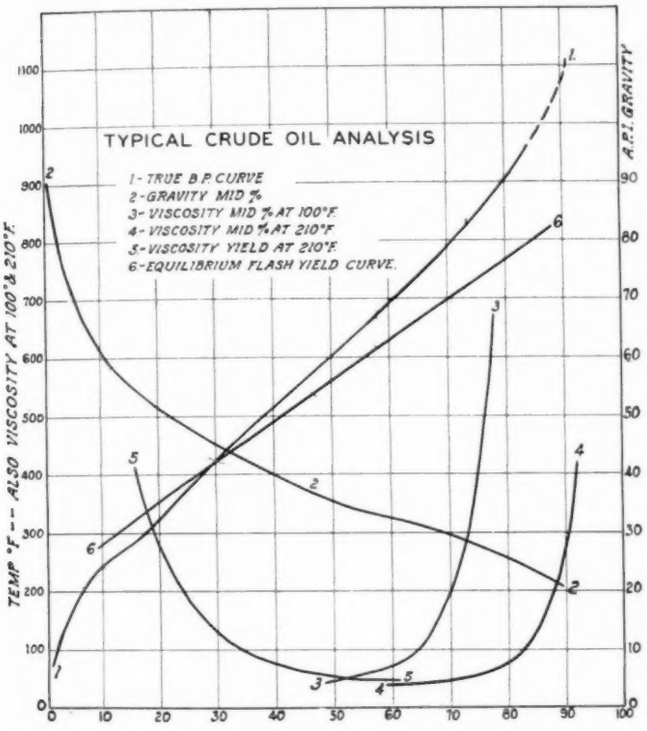
TYPICAL CRUDE OIL ANALYSIS
1-TRUE B.P. CURVE
2-GRAVITY MID %
3-VISCOSITY MID % AT 100°F.
4-VISCOSITY MID % AT 210°F.
5-VISCOSITY YIELD AT 210°F.
6-EQUILIBRIUM FLASH YIELD CURVE.
TEMP °F -- ALSO VISCOSITY AT 100° & 210°F.
A.P.I. GRAVITY

FIGURE I

always hot reflux. At the top of the tower the internal reflux is the same as the hot reflux. The internal reflux liquid or its corresponding vapor may be computed at any plate in the column by dividing the reflux heat at that plate by the latent heat of the liquid on that plate. For clarity the reflux should be designated as the internal reflux at the kerosene plate or at the gas oil plate, etc. A heat balance up to the kerosene plate would involve the same heat quantities as the above balance except that the gasoline would be cooled only to 440 degrees F. and the steam would be heated to 440 degrees F. The reflux heat at the kerosene plate would be 2,011,000 B. t. u. per hour and the internal reflux at the kerosene plate would be 2,011,000 ÷ 88, or 22,860 # per hour. Since the kerosene is drawn from this plate, 22,860 # per hour of reflux flows onto the plate, but only (22,860—2860), or 20,000 # per hour flows to the plate below. Contrary to common belief, when using the corrected latent heats there is often a larger quantity of reflux liquid or

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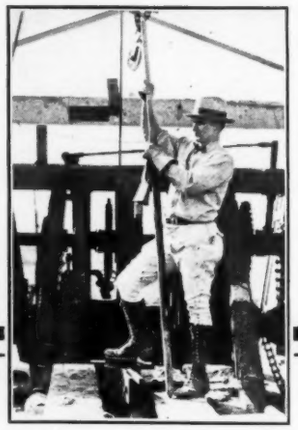

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vapor to be handled at the kerosene plate than at the top of the column.

Some confusion exists regarding the term reflux ratio. If, by reflux ratio, we mean the pounds of external reflux divided by the pounds of top product, we have a useless definition. Since the quantity of external reflux varies with its temperature, any ratio involving external reflux will vary, even though the same reflux heat is removed. Nevertheless, such a definition of reflux ratio is the one most commonly used. It seems preferable to define the reflux ratio as the pounds of internal reflux divided by the pounds of top product. By such a definition the reflux ratio in the example calculation would be 3.38 for any type of reflux.

By the method of heat balance, only the minimum amount of reflux is determined. The gasoline and products drawn high in the column are well fractionated, but those drawn near the vaporizer receive less reflux and are less well fractionated. The reflux required by a heat balance is only enough to keep all of the plates sealed with liquid and provide a minimum of reflux at the vaporizer section.

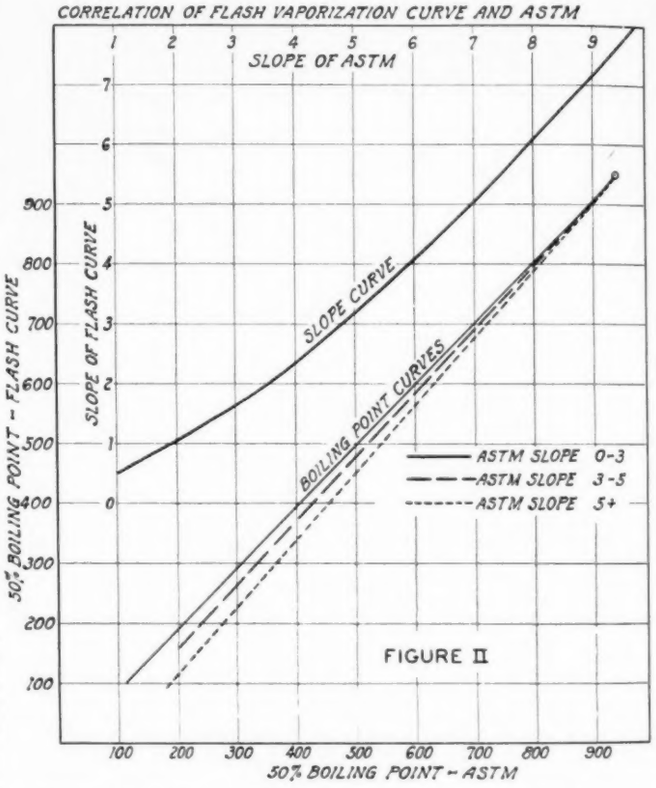

FIGURE II

If more reflux is desired in the lower part of the column, part of the bottoms must be vaporized. This requires not only a higher vaporizer temperature but also additional top reflux in order to condense the vaporized bottoms. One of the large companies has gone so far in this respect as to vaporize the entire feed material (although a 25 per cent bottoms was produced from the unit) and, in addition, to add 70 degrees F. of superheat to the vaporized feed. Doubtless excellent fractionation resulted, and in this particular case, in which additional reflux materially improved the color, the excess reflux may have been justified. But when using excess reflux the tower diameter must be larger, the still must be larger, and the reflux condensers must be larger. Unless the tower is made amply large, the advantage gained by excess reflux may be entirely undone by overloading of the tower. Nevertheless, an excess of reflux does have certain advantages, such as increasing yields or decreasing treating operations, which may more than pay for the additional investment in equipment.

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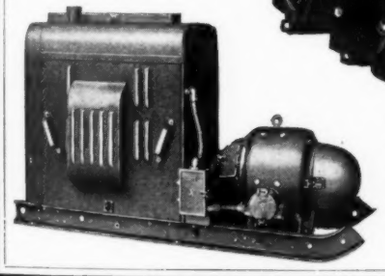

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Apparently, in a single column it is not possible to effect a sharp separation of more than two products. That is, all of the side-drawn materials contain small amounts of the lighter products because the overhead product and those products drawn from plates higher in the column must pass the intermediate plates and thus influence the composition of any intermediate products. In commercial operation this tail of lighter material is commonly removed by steam stripping in an auxiliary column.

The Equilibrium Flash Vaporization Curve [6 7 8]

The difficulty of calculating, by means of equilibrium relationships, the partition between liquid and vapor of a liquid feed flashed at a given temperature and pressure has led to the use of an empirical relationship called the "equilibrium flash-vaporization curve" or the "flash-yield curve." This curve relates (for a given oil flashed at a given pressure) the equivalent liquid volume of the vapor formed, expressed as per cent of original liquid or feed, and the temperature of the vaporization. (Fig. I, curve 6.)

This curve may be obtained experimentally by heating the oil without allowing the vapors to separate from the remaining liquid until the final flash temperature is reached. At the final temperature the liquid in equilibrium with the vapor is removed and measured, and the equivalent liquid volume of the vapor obtained by difference. By heating the oil to a succession of flash temperatures a curve may be developed which expresses the percentage of vaporized material at any flash temperature.

From a study of 58 flash-vaporization curves the authors have developed a method of predicting the flash curve of an oil from its distillation curve. The method of correlation is similar to that employed by Piroomov and Beiswenger[7], but it covers a wider variety of oils and appears to apply somewhat more accurately than does the correlation of Piroomov and Beiswenger. It should be noted, however, that any simple method of predicting quantitatively the complex relationships involved in the flashing of petroleum oils is necessarily an approximation and should be applied with conservatism.

Figures II and III summarize the method of predicting the flash yield curve from the distillation curve. The slopes of both the distillation and flash curves are taken between the 10 per cent and 70 per cent points. The two slope scales are related by the slope curve and the boiling point scales by the boiling point curve or curves.

The average boiling point of a complex material, such as gasoline, may be determined by noting the 100 per cent point on the flash curve of the gasoline. Perhaps a better name for the average boiling point is "equilibrium boiling point." Only when this temperature is attained will the material be completely vaporized. Furthermore, if the vaporized material were to be cooled slowly, condensation would not be complete until the zero per cent point on the flash curve had been reached.

Pipe still vaporization closely simulates flash vaporization. Condensation in the coil-in-box condenser roughly approximates equilibrium condensation, although it is probable that the mixing of the material in the coil is not thorough enough to establish equilibrium. Recent investigations indicate that the assumption of equilibrium conditions in the bubble-tower is sufficiently accurate for the calculation of tower temperatures used in making heat and material balances.

Estimation of Tower Temperatures

Designers with broad experience are able, frequently, to estimate tower temperatures by an inspection of the behavior of operating plants. Such a guessing method, how-

[6] Leslie and Good, Ind. and Eng., Ch., 19, p. 453 (1927).
[7] Piroomov and Beiswenger, 9th Annual Proceedings of the A. P. I. (1929).
[8] Brown and Skinner, Ind. and Eng., Ch. 22, p. 278 (1930).

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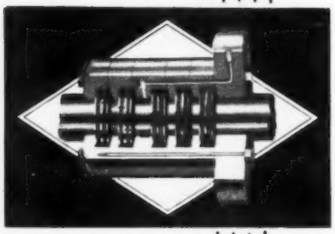

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ever, is inadequate when a new design problem, such as a vacuum tower, is presented. Certainly the novice cannot depend upon a few scattered plant data for the estimation of tower temperatures. As an aid to such estimation, numerous correlations of tower temperatures with the distillations of the products have been attempted, but apparently with little success. At present, applications of the flash yield curve appear to provide the simplest and most satisfactory means of estimating tower temperatures.

The top temperature is dependent upon the equilibrium boiling point of the top product. If no inert material, such as steam or gas produced by cracking, passes out of the top of the tower, the equilibrium boiling point of the top product corrected for the tower pressure is the top temperature. When fixed gases are present, the equilibrium boiling point must be further corrected by the partial pressure effect of the fixed gases. In such a case the gaseous material at the top of the tower would consist of overhead product, internal reflux and fixed gases. If the tower of Sketch No. 1 were operated with 900 pounds of steam per hour and the top pressure was one pound per square inch gauge, the quantity of vapor would be as follows:

$$\text{Gaso. Product} \quad \frac{6730}{118} = 57 \text{ mols per hour}$$

$$\text{Reflux} \quad \frac{22750}{118} = \frac{192}{249}$$

$$\text{Steam} \quad \frac{900}{18} = \frac{50}{299} \text{ mols per hour}$$

With an equilibrium boiling point (the 100 per cent point on the flash curve) of 340 degrees F. at 760 mm. the top temperature would be:

$$\text{Partial pressure of oil} = \frac{249}{299} \times \left(760 + \frac{760}{14.7}\right) = 675 \text{ mm.}$$

340° F. corrected to 675 mm.[9] = 328° F.

Without steam the top temperature would be:

340° F. corrected to 1 pound gauge = 343° F.

Because the vapor pressures of pure normal paraffins have been used for correcting the vapor pressures of complex mixtures of hydrocarbons, the calculated top temperatures are higher than the observed temperatures. The average deviation is about 10 degrees F. and the maximum about 15 degrees F. Hence, the actual top temperature in the case above, with steam, would be about 320 degrees F.

The calculation of side temperatures is substantially the same in principle as the calculation of the top temperature. But at a side-draw plate not only do we have the side product and reflux vapor, but also the vapors of the products collected at higher points in the column. Some of these vapors are far above their boiling point or may even be above their critical temperature, so that they act as fixed gases. As a working assumption the second more volatile product is regarded as acting as a fixed gas. Following Sketch No. 1, the gasoline vapor would be regarded as a fixed gas with respect to gas oil. If wax distillate were being produced, the kerosene and gasoline would be considered as fixed gas. Although such a method is empirical, nevertheless the theory appears to be valid and the computed temperatures check plant data closely.

Calculation of the temperature at the kerosene plate will serve to illustrate the method. The equilibrium condensation point for the kerosene product is 457 degrees F. and the plate pressure is two pounds gage. The condensation point of 457 degrees F. corrected to two pounds or 863 mm. is 463 degrees F. This would be the temperature if no steam

[9] W. L. Nelson, this journal, May, 1931.

were used. If the tower were using 50 mols of steam per hour, other conditions the same, the plate temperature would be:

Gasoline Product	57	mols per hour
Kerosene Product	$\frac{2860}{192}$	15
Internal Reflux	$\frac{20000}{192}$	$\frac{104}{176}$
Steam	50	
Total	226	mols per hour

$$\text{Partial Pressure} = \frac{176}{226}\left(760 + \frac{760}{14.7} \times 2\right) = 673 \text{ mm.}$$

457°F. Corrected to 675 mm. = 445°F.

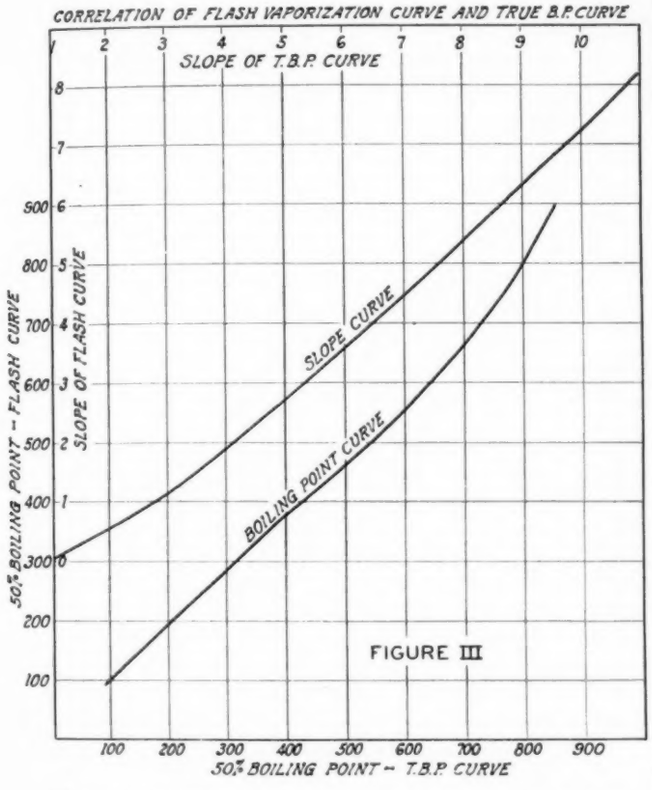
CORRELATION OF FLASH VAPORIZATION CURVE AND TRUE B.P. CURVE
SLOPE OF T.B.P. CURVE
SLOPE CURVE
BOILING POINT CURVE
50% BOILING POINT - FLASH CURVE
SLOPE OF FLASH CURVE
50% BOILING POINT - T.B.P. CURVE

FIGURE III

The gas oil plate temperature would be calculated in a similar manner except that the partial pressure of the gas oil, kerosene, and internal reflux would be lowered by steam and gasoline vapor.

The flash vaporization curve is not a straight line as is the computed flash curve. The general curvature of the distillation curve is reflected in the flash curve so that "tails" exist at both ends of the almost straight curve. In this paper the flash curve has been regarded as a straight line throughout and the zero and 100 per cent points have been read on this straight line. For this reason the calculated equilibrium boiling and condensation points are slightly in error. This method gives plate temperatures which check plant operation within ∓ 5 per cent.

No satisfactory method of computing the bottom temperature has been devised. Apparently this is due not so much to inadequate design methods as to incorrect bottom temperature measurements. In a few cases in which the temperature on the last stripping plate was recorded, the bottom temperature was successfully calculated.

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If you have such photographs, we shall appreciate your permitting us to reproduce them in our pictorial section. Extreme care will be exercised in handling them and they will be returned in the same condition as received. Kindly address photographs to

THE PETROLEUM ENGINEER

Exchange Bank Bldg. Tulsa, Okla.

Combustion in the Petroleum

TWO of the major items entering into manufacturing costs are fuel and power, but as the power cost is in many instances a function of the fuel cost, these two items can be considered as one. In the refining industry, fuel cost is an important factor. Fuel is used for distillation equipment, in the boiler house, power plant, in clay kilns and retorts and in cracking furnaces. The fuels available are natural gas, artificial gas from cracking stills, fuel oil, tars, acid sludge, coke and coal. Each of these present a distinct problem in handling, combustion and design. In many cases, the design must be flexible enough to handle more than one type of fuel economically.

Fuel consumption of refineries will vary considerably, depending on the crude throughput and the manufacturing processes employed. The following figures are based on conversion of other fuels to a fuel oil basis in accordance with the B.T.U. value of the fuel used. We give in Box A, table showing fuel consumption of some typical refineries for the year 1930:

Type of Plant	Daily Average Crude Thruput	Location	Type of Crude Run	Percent Fuel Burned
Complete	2,500	Oklahoma	Mid. Con.	21.50
Complete	2,500	Pennsylvania	Pennsylvania	17.50
Complete	2,500	Texas	No. Texas	18.60
Skim. & Cracking	3,000	Kentucky	Kentucky	8.50
Skim. & Cracking	3,500	Texas	Texas	13.00
Complete	3,500	Oklahoma	Mid. Con.	16.50
Complete	3,700	Oklahoma	Mid. Con.	23.10
Skim. & Cracking	4,000	Oklahoma	Mid. Con.	11.80
Complete	4,000	Texas	No. Texas	18.20
Skim. & Cracking	4,000	E. Coast	Mixed	9.60
Skim. & Cracking	5,000	Missouri	Mid. Con.	8.20
Complete	9,000	Oklahoma	Mid. Con.	15.40
Skim. & Cracking	10,000	Texas	Panhandle	13.50
Skim. & Cracking	15,000	E. Coast	Mid. Con.	7.00
Skim. & Cracking	20,000	Illinois	Mid. Con.	7.50

The above table shows a wide variance in the amount of fuel used, even for plants of the same capacity. This variance may be caused by the type of distillation apparatus employed, the number of products manufactured, the extent to which cracking is carried out and various other factors so that in order to make an intelligent study of the fuel economy at any plant, it becomes necessary to make a thorough analysis of the entire operations.

A survey made by the Bureau of Mines* shows that there has been a steady reduction in the amount of fuel consumed to refine a barrel of crude. In 1925, refiners used an average of 829,000 B.T.U. to refine a barrel of crude; whereas, in 1929, this average had been reduced to 639,000 B.T.U., a decline of 23 per cent. Based on the B.T.U. equivalent, this would still mean a fuel consumption equal to 10 per cent of the crude throughput.

While fuel oil is the principal fuel used at refineries, appreciable quantities of coal, gas, and coke are consumed. While part of the decrease in fuel consumption is undoubtedly due to better design as well as the introduction of more efficient heat exchange apparatus, yet the major portion of it is due to the substitution of continuous distillation equipment for batch distillation equipment and greater economies can still be obtained by a careful study of the design of equipment and the utilization of the fuels employed.

Fuels are essentially compounds of hydrogen and carbon with small amounts of nitrogen, sulphur and oxygen compounds. These elements may be combined in different proportions to form different chemical compounds, and it is necessary to know the chemical composition of a fuel in order to properly understand the fundamentals of combustion and the economic utilization of fuels.

We will present herewith standard methods for the analysis of gaseous, liquid, and solid fuels. Gaseous fuels are generally analyzed to determine the percentage of each constituent such as carbon dioxide, methane, ethane, higher hydrocarbons, oxygen, and nitrogen. The liquid and solid fuels contain so many compounds and their isolation is so difficult that it is customary to simply determine the percentage of carbon, hydrogen, sulphur, nitrogen, etc., by elementary analysis.

It is possible to calculate the heating value of a fuel from its chemical analysis, and also the amount of air required for combustion and the amount and character of the products of combustion. While the heating values calculated from the analysis are fairly accurate, it is always desirable to check these by burning a certain amount of the fuel in a standard calorimeter. The percentage of carbon and hydrogen of a liquid or solid fuel is determined by burning a weighed sample of the fuel under certain fixed conditions. The products of combustion are absorbed and from the water vapor and the carbon dioxide, the percentage of carbon and hydrogen is calculated.

Apparatus and Chemicals Required for the Determination of Carbon and Hydrogen

(1) Tank of oxygen with reducing valve.
(2) Electric combustion furnace.
(3) Pyrex combustion tube.
(4) Copper gauze, 40 mesh.
(5) Copper wire, No. 16.
(6) Bubble counter.
(7) Two "U" tubes with ground glass stoppers for drying train.
(8) Two absorption bottles.
(9) One porcelain boat with weighing tube.

It is necessary to purify the oxygen used for the combustion, especially as oxygen manufactured by electrolysis contains small amounts of hydrogen. The hydrogen can be removed by first passing the oxygen through a small combustion furnace, holding a combustion tube with a copper spiral about 4½ inches long. Any hydrogen is oxidized to water in this preheater. The oxygen is next passed through a purifying system consisting of two "U" tubes, the first of which is filled with soda lime and the second with alumina saturated pumice. This purifying train removes any traces of carbon dioxide or water left in the oxygen. It is quite important that the same type of purifying material is used in the purifying system as is later used in the absorption apparatus.

Refining Industry

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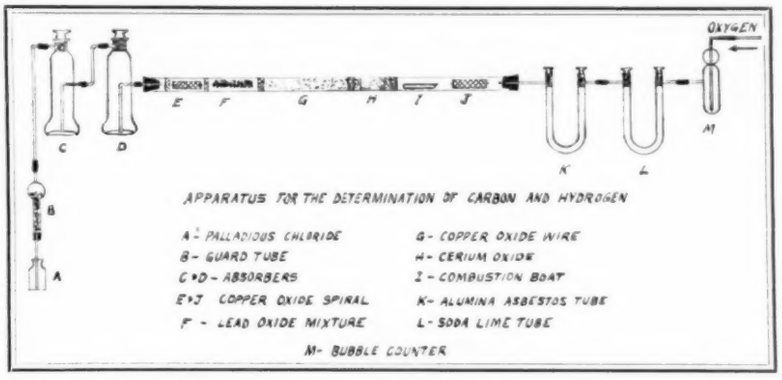
The combustion furnace should preferably be divided into three sections with individual heat controls on each section.

The combustion tube proper consists of a pyrex glass tube about 30 inches long and six tenths of an inch inside diameter. It is filled as shown in the accompanying figure. At the end nearest the purifying train is placed a copper oxide spiral, approximately three inches long. This copper oxide spiral is made by winding some 40-mesh copper gauze over a piece of No. 16 copper wire, the ends of the wire being bent in a hook so as to make the removal of the copper oxide spiral comparatively easy. Then follows the combustion boat, containing the material to be burned and following this, about two inches of Cerium Oxide Catalyst retained between two asbestos wads.

The Cerium Oxide Catalyst is prepared by saturating sufficient twelve mesh pumice with five gms. of cerium nitrate dissolved in sufficient water to thoroughly saturate the pumice and then evaporated to dryness on the steam bath. The Cerium Oxide Catalyst is followed by another asbestos wad, ten inches of copper oxide wire cut into small pieces, and then by approximately eight to nine grams of a mixture of lead peroxide and minium (Pb_3O_4). This material is usually placed in a large combustion boat or else in a tube of hard glass which fits inside the combustion tube. The lead peroxide mixture absorbs any nitrogen, sulphur or halogen compounds present in the fuel oil to be tested. Another small copper oxide spiral is usually placed at the end of the combustion tube before it enters the absorbers.



The apparatus is assembled by connecting the supply of oxygen to the drying train, then to the bubble counter, then to the furnace. The products of combustion from the furnace pass first through an absorption apparatus filled with pumice saturated with aluminum oxide for the determination of water. The aluminum oxide can be prepared according to the method given in Dr. H. L. Fisher's Laboratory Manual of Organic Chemistry, John Wiley & Sons, Inc., page 239, or else calcium chloride about eight-mesh can be used in the first bottle. The second absorption bottle for the absorption of the carbon dioxide is filled with soda lime or else a solution of caustic potash containing approximately fifty per cent of KOH can be used for this purpose. At the end of the combustion train, it is advisable to place an additional calcium chloride tube to act as a guard and finally a small absorption bottle containing palladious chloride. The palladious chloride solution is used to detect the presence of carbon monoxide in case the combustion is not complete.

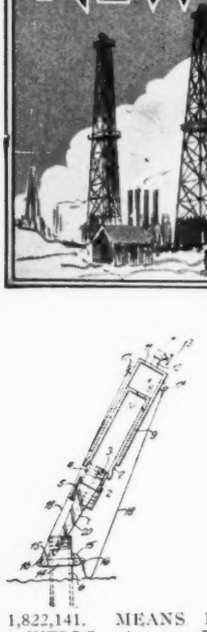
After the entire apparatus has been assembled and tested to see that it is air tight, it is cleaned as follows: The oxygen is turned on and the rate of flow is adjusted so that two or three bubbles a second pass through the bubble counter. The heat is gradually turned on and after the tube is thoroughly warmed, the tube is heated to a dull red heat. The heat is continued for approximately five minutes, then the current is shut off. The oxygen being allowed to pass through until the tube is fairly cool. The apparatus is now ready for the combustion of the fuel to be analyzed. Two-tenths to three-tenths of a gram are carefully weighed out in a porcelain boat, care being taken in the case of volatile fuels to see that there is no loss by evaporation. The purifying train is disconnected from the combustion tube, the roll of oxidized copper gauze is carefully removed from the combustion tube and the boat containing the substance to be burned is carefully placed at the proper position in the tube. The oxidized gauze is replaced, the purifying train is reconnected and the oxygen is connected to the tube. The oxygen and heat must be so regulated that the entire substance will be completely burned in from ten to twenty minutes. The burning must be carefully watched and the rate of flow of oxygen carefully controlled. A black precipitate in the palladious chloride solution indicates incomplete combustion and the determination must be repeated. The end of the combustion is indicated when the boat is clean and free from carbon particles, but the stream of oxygen should be continued for at least thirty to forty minutes longer in order that the products of combustion may be completely absorbed. After this is finished, the two absorption bottles are disconnected, closed and weighed. Calculation of results. The percentage of carbon and hydrogen are obtained from the following equations:

$$\text{Per Cent Hydrogen} = \frac{\text{Weight } H_2O \times 2.016 \times 100}{\text{Weight Substance} \times 18.016}$$

$$\text{Per Cent Carbon} = \frac{\text{Weight } CO_2 \times 3 \times 100}{\text{Weight Substance} \times 11}$$

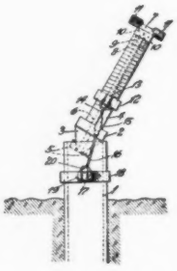
A blank determination should always be run to eliminate the possibility of any errors and two combustions on the same material should always be run and should check within very narrow limits.

NEW PATENTS OF THE INDUSTRY



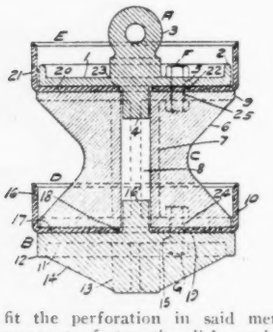
1,822,140. PLUG FOR OIL WELLS AND APPARATUS FOR SEATING THE SAME. ANDREW J. GALLAHER, St. Louis, Mo. Filed Apr. 17, 1930. Serial No. 444,912. 6 Claims. (Cl. 166—15.)

1. A device of the class described comprising a conical plug having a passage therethrough, a fitting adapted to secure the plug to a well casing when in position, and means operable by the pressure of the well to assist in forcing the plug to position.



1,822,141. MEANS FOR CLOSING OIL WELLS. ANDREW J. GALLAHER, St. Louis, Mo. Filed May 26, 1930. Serial No. 455,490. 10 Claims. (Cl. 166—15.)

1. A device of the character described comprising a body adapted to be moved into the open end of an oil well casing and having a longitudinal passage therethrough, a means at the outer end of said passage for utilizing the escaping pressure to rotate said body, and means for moving said body longitudinally into an oil well casing when said body is rotated by said pressure.

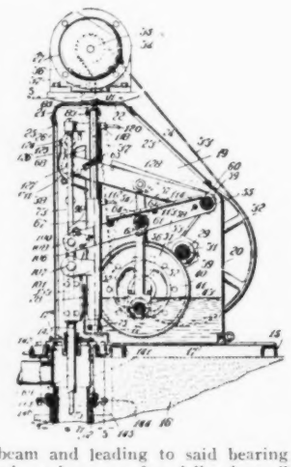


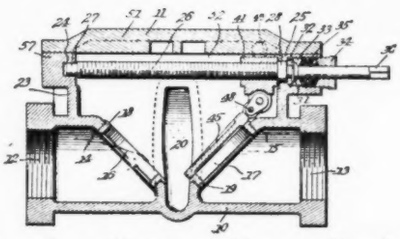
1,822,193. PLUG FOR CEMENTING WELLS. SIDNEY O. BARTON, Long Beach, Calif., assignor to Pacific Oil Well Cementing Company, Incorporated, Los Angeles, Calif., a Corporation of California. Filed Mar. 18, 1929. Serial No. 348,074. 2 Claims. (Cl. 166—1.)

1. In an apparatus for cementing wells, an assembled spool shape frangible metal plug having spaced cup packings and an intermediate perforated ribbed reinforcement member, said ribbed member having at its top an interior disk integral with the ribbed member, an outer disk having an eye on one side and a plug to fit the perforation in said member on the other side of the disk and means to fasten the disks and packings together.

1,822,546. PUMPING APPARATUS. JOHN B. SPERRY, Aurora, Ill., assignor to The American Well Works, Aurora, Ill., a Corporation of Illinois. Filed Aug. 29, 1925. Serial No. 53,274. 19 Claims. (Cl. 184—4.)

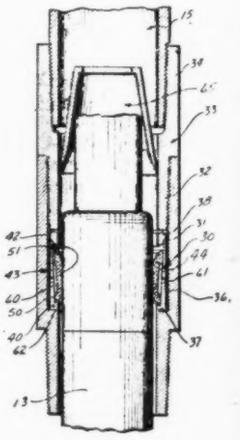
9. In a pumping apparatus, the combination with a chamber adapted to contain a body of oil, a crank shaft mounted in said chamber, and means for rotating said crank shaft, of a vertically reciprocating cross-head a guide therefor, a walking beam mounted to swing vertically in said chamber and operatively connected to actuate said cross-head, a pitman connected at its lower end with said crank shaft and at its upper end with said walking beam, and means for forcing oil from said chamber between the cross-head and its guide to the upper bearing of said pitman comprising a duct carried by the walking beam and leading to said bearing from a point adjacent to said cross-head, and means for delivering oil from said cross-head to said duct.





1,821,992. VALVE. HARRY F. STEVENS, Bartlesville, Okla. Filed June 2, 1930. Serial No. 458,942. 14 Claims. (Cl. 251—118.)

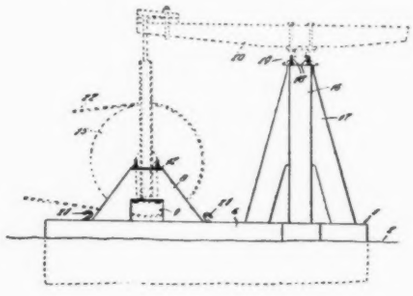
14. In a valve, a casing, a port in said casing, a closure plate for co-operation with said port, means for moving said plate away from said port comprising a rectilinearly movable member engaged with the plate, and means for swinging said plate about the line of movement of said member as an axis to move the plate out of overlying relation to the port, said plural means being operable in positively enforced reverse sequence to seat the plate on the port.



1,822,412. NOVEL PACKER FOR USE WITH OVERSHOT. GERHARD MEYER, Los Angeles, Calif. Filed Oct. 1, 1929. Serial No. 396,450. 16 Claims. (Cl. 294—90.)

1. In a packing device for sealing primary and secondary elements, the combination of: a packing-retaining structure rotatably engaging one of said elements; and a packing member retained in said packing-retaining structure and compressed against the other of said elements.

1,822,268. OIL WELL RIG. ROBERT T. BOLES, El Dorado, Ark., assignor of one-half to Harry C. Steinberg, El Dorado, Ark., and one-half to Phillips Petroleum Company, Bartlesville, Okla. Filed Nov. 1, 1929. Serial No. 404,193. 2 Claims. (Cl. 308—25.)



1. In an oil well rig, a foundation comprising substantially parallel side walls, an end wall joining the side walls, a standard on each of the parallel walls, a post on one of the side walls at the point where that wall joins the end wall, and an inclined brace extending from the post downwardly on to the end wall, all of said parts being integral and formed of concrete.